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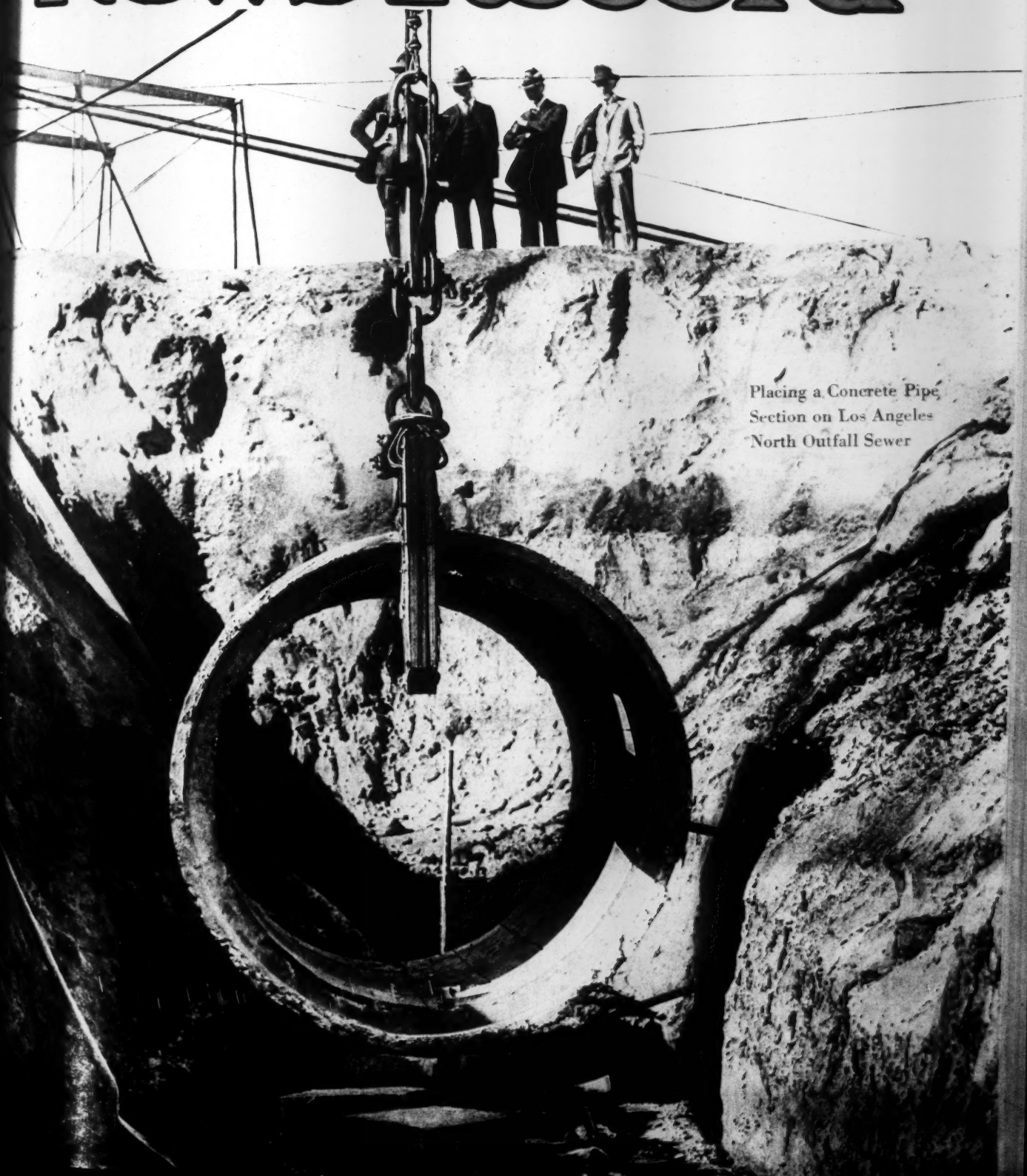

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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FRANK C. WIGHT
Editor

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A Return to Reason

IT HAS taken Europe five years to come to the inevitable conclusion that post-war readjustment must be made purely on an economic basis. Home politics, nationalistic aims and jealousies, security for the future and war hatred all have governed the policies of the European chancelleries attempting to settle the peace, and all have failed. There remained only a settlement based on fundamental economics—and that is what the Dawes Commission took for its guiding star. Up to now any suggestion or plan that called forth approval from any one party in the involved tangle of interests was by that very fact anathema to all the other parties. Not so with the Dawes report. The remarkable fact is—and that fact marks the turning point in the move toward readjustment—that England, France and Germany have all accepted the Dawes plan. Not that this means the immediate installation of all the complicated financial machinery that the plan recommends but it does mean that Europe is ready to go along with some rational scheme which takes for its basic principle that while Germany must pay for the war it can only do so by selling the things it makes to the rest of the world. If by so doing she threatens to achieve a domination of the markets of the world the creditor nations will have to choose between permitting this domination or lowering their expectation of payment. This is not the victory anticipated on Armistice Day or promised by the Versailles treaty, but it is the conclusion that five years of pointless economic struggle has led to. The Dawes Commission recognized it and has translated it into a working plan, based on business principles unprejudiced by national or political considerations. The plan must go through because Europe has at last realized that economics, not passions or memories, eventually must govern world relations.

Cement to Be Studied

WHEN the first announcement was made of the appointment of the Advisory Committee on Cement and Concrete by the Department of Commerce we voiced some wonder at the vague, but ambitious, program which the committee had apparently set itself. Scientific investigations into the methods of making concrete, the development of equipment, the problems of seasonal construction and continuous employment—all were to be looked into and collated and correlated under the protecting aegis of government. At last we were going to learn something about cement and concrete, and all our helpless flounderings to that end through the past couple of decades were to be straightened out and directed by master hands. It was an unfortunate preliminary announcement of a purpose which, we believe now, was a laudable one but which was certainly self-misrepresented so that it could not help being misunderstood. The committee has now come down to earth. It has a definite program of study of cement, reprinted on p. 725 of this issue. This is useful work, not only the study itself which is something that needs to be done but the bringing together of the Bureau of Standards and the Portland Cement Association in that study. These two agencies are excellently equipped for the analytical investigation into the properties of hydraulic cements, an investigation that has lagged for too many years because of the easy assumption that cement had been perfected. The Advisory Committee can well serve the construction field by fostering this co-operation and seeing that it really results in active work.

Bates Road Passes

THEY are tearing up the Bates test road. In a few months the sections which have endured the pounding of an army of motor trucks will be smoothed up and the sections which went down under the attack will be replaced with new pavement of the construction which endured and the whole will become a link in the Springfield-Jackson highway now otherwise completed. Only a mile long, built only as a field laboratory, designed only to be destroyed, no road so focussed the attention of highway engineers for two years as did the Bates test road. Probably no highway tests have been more vigorously praised and more violently criticised. Perhaps their precise service to highway design will never be a subject of agreement. Admitting all the inconclusiveness claimed of them, however, the Bates road tests have been well worth while. They have introduced a definite theory of rigid pavement design into road engineering practice. Time may, as time usually does, modify the theory, but at the moment it stands out a determined point in the speculation of highway engineers. The Bates road has given some degree of certitude of thought in the rational design of paved roads. In this matter it was a great enterprise and its promotors deserve praise.

Rainfall vs. Football

STADIUM construction which in the past few years has assumed the proportions of an epidemic among American universities, usually has confined itself to the mere provision of a physical structure large enough and structurally adequate to receive the growing throngs attending undergraduate athletic contests. Peak crowds, naturally, are expected at football games, though provision for track meets and baseball games has usually been included in stadium plans. Unique, therefore in at least two respects is the stadium completed late last year in the hills at Berkeley, for the University of California. The structure encloses an area for football alone; and drainage and soil studies were the principal design preliminaries. By filling with more or less impervious earth over a former creek bed;

by packing that fill to establish a new permanent water table and then overspreading it with pervious earth topped with special grasses; and by installing tile drains, provision has been made whereby games can be played on a comparatively dry field within an hour after worse 24-hour downpours than the state has ever known have been recorded. The cost of the stadium must be secured largely on receipts from one game a year. The California playing field has therefore been a laboratory study; and only other considerations than cloudbursts immediately preceding schedule game time will silence the referee's whistle.

Grade Crossings and Union Stations

IN ITS decision a few weeks ago on the Los Angeles Union Station case the United States Supreme Court definitely established the rights of a state to order grade-crossing elimination but at the same time denied it the right to tie this elimination up to an order for joint terminals or for elaboration of station facilities. Unfortunately some news agencies misinterpreted the decision to mean that a state body had no control over grade crossings and this misinterpretation has caused some concern in municipal and railway circles, as a reversal of an accepted right. The decision is therefore worth some explanation.

Proceedings in this case were begun in 1916 before the California Railroad Commission by complaints of Los Angeles civic association and others to require the three railroads coming into the city to remove certain grade crossings and build a union terminal within a certain defined area in the city. The commission issued an order to this effect in 1921 requiring not only the elimination of grade crossings but the joint use of $28,000,000 worth of tracks and terminal facilities, the abandonment of three existing passenger stations as such and the ultimate expenditure for all recommendations of from $25,000,000 to $45,000,000. The railway companies sought review of this order and took it to the state supreme court which held that if the order had effected the elimination of grade crossings alone it would have been valid but that associated with the establishment of a union station it must be annulled. On April 7 of this year the U. S. Supreme Court affirmed the judgment of the California court.

In sustaining the California Supreme Court the federal court quoted the inferior court's statement "that notwithstanding the views expressed by the railroad commission in its findings and conclusions we can perceive no indispensable relation between the elimination of grade crossings and the establishment of union depot facilities, nor can we see any unsurmountable difficulty why jurisdiction over the matter of eliminating grade crossings may not be exercised in a proper case consistently, and it may be concurrently, with the exercise of the authority which is vested by the act of Congress of 1920 in the Interstate Commerce Commission over the subject of union terminal depot facilities." The United States Supreme Court then said: "The state court thus modifies the findings of the railroad commission in so far as they sought to tie the validity of its order establishing a union station to its unquestioned police power to regulate grade crossings in the interest of public safety."

Both courts thus refused to sustain the railroad commission in its attempt to force the railroad companies to build a union station on the ground that it was essential to the program of grade-crossing elimination in Los Angeles.

There is no question of the right of the California Railroad Commission to order the elimination of grade crossings but when the commission attempted to extend this power to order the abandonment of three stations, one of which is comparatively modern, and the expenditure of many millions of dollars in a union station without any regard as to how the three railroads concerned were to finance such an expenditure it exceeded its authority. The responsibility for an order of this kind rests with the Interstate Commerce Commission, the body which is vested not only with the control of railroad expenditures, but with the control of the rates which make possible such expenditures. The Supreme Court has not complicated the grade crossing issue—it has clarified it. The railroads now know that they must deal with state authorities in matters concerning crossing elimination, and cities can rest assured that their grade-crossing problems will not be carried to Washington to be lost in the files of the commerce commission. On the other hand, they also know that they cannot embellish their cities with costly railroad facilities simply by including such facilities in their crossing elimination plans.

A Service to the Country

THE long awaited report of the Board of Reclamation Advisers is at hand. It is an epoch-making document. Courageous, farseeing and shrewd, it deals in masterly way with the problems both of the projects already built and of those that may be built in future. If carried into effect with the wisdom and firmness that speak from its findings, it may be counted on to dispose of the troubles of reclamation, adjusting those that are real and silencing complaint about those that are fictitious. The men who wrote it have produced a result worthy of their long labors. They have done the country a notable service, and every citizen owes them thanks.

It is no disparagement of what they accomplish to say that in some measure their report owes its importance to opportunity and timeliness—often in themselves sufficient to give greatness. Much of what the advisers find and recommend has been stated before. There have been other investigations of reclamation, in part or in whole, and more than one report has pointed to the critical elements and indicated the remedies. But, as the present report truly says, "the findings of these investigations are buried in the files and have apparently been given but little consideration." Political administration did not give them opportunity to come to fruition. The present study of the subject had the decisive advantage of being directed toward the problem in its entirety, and the board did not neglect to use this advantage. Again, because the reclamation problem has become a national issue, involved in a maze of recrimination and intrigue, the time is at last ripe for its adjustment. The remarkable report now at hand is fully equal to the opportunity.

To engineers the first significant feature of the re-

port is its endorsement of the Reclamation Service, the organization indicted and denounced by Secretary Work. Sitting as a court to try the indictment, the Board of Advisers has acquitted the engineers, not with the Scotch verdict of "not proven," but with warm testimonials. The many charges to the effect that reclamation troubles were due to excessive cost of the projects and to incompetent administration, for both of which engineers were responsible, are thrown out of court.

From a broader viewpoint, the leading feature of the report is its emphatic re-affirmation of the underlying principle on which reclamation was built: that irrigation work should be constructed not as a gift or subsidy, but as a loan to be repaid by the land benefited. Throughout the report of the advisers, every pronouncement supports this principle, and emphasis is placed on the doctrine that irrigation development which cannot support its cost is unsound and should not be carried out. That a full and sympathetic study of reclamation troubles led the board to reaffirm this principle is sufficient in itself to assure the lasting value of the report.

Serious defects exist in the reclamation law as it has been applied, despite its sound basic principle. It is out of these defects that most of the reclamation troubles have grown, the report indicates. Because of the defects of the law, and more directly because of stunted development of the projects due to them, large losses fall on the national treasury, possibly more than $25,000,000. Three projects are total failures, and on several others only part of the money invested can be repaid. The reasons for these losses, too complex for present review but fairly indicated in the series of reclamation articles and letters which we published some months ago, do not lie in engineering failure. They represent the cost of learning that the same hard truths apply to federal irrigation as to the countless private irrigation enterprises which have proved to be financial mirages.

All the valuable teachings of this costly experience, however, are recorded in the report of the Board of Advisers, either in express terms or by implication. We are told that a reclamation project must not be decided upon because a politician or a party or a railroad wants it, that this is simply courting disaster. Soil, climate and market must be favorable, and agriculture must be made a going business from the start or it will be smothered by the piling up of its own operating losses. This means extensive help to the farmer in starting—help by land-leveling machinery, money, and counsel. And so, point by point, the requisites of sound development are laid down. But we are assured that if these be observed, the development of irrigation for arid lands can be made a definite success.

These lessons are for future utilization. In the troubles of the present projects the advisers faced the problem of adjusting grievances, remedying injustices, and writing off enough to put all projects not merely on a solvent but also on a hopeful basis. This they accomplished skilfully and wisely, making due compromise between strict logic and too great concession. But above and beyond this, they identified and prescribed for the three major diseases of the projects: poor soil, inflexible repayment system, and usurious loan interest. The remedy for the first and second will find unqualified endorsement. Land classification and proportionate adjustment of construction charge has obvious justice. The same is true of differentiating the rate of repayment on fertile and profitable projects from that on projects of lower earning power, though the plan is no more proof against crop failure, insect pests, or low crop prices than is the present system. Projects that heretofore have paid nothing on the construction cost will hardly be much better able or willing to pay a percentage of mean annual crop value than they were to pay a percentage of the construction cost. Nevertheless, the proposed remedy is sound, and should be applied. As to the remedy for high interest rates, on the other hand, there is sure to be discussion. A vast governmental loan system is a new and formidable thing. Yet nothing is more certain than that a mortgage-burden of $50 or more per acre at 10 per cent spells ruin for the farmer.

Typical of the courageous directness with which the Board of Advisers deals with unpleasant facts is its rebuke of the helpless attitude of the project farmers, of their view that they are special wards of the government. There is likely to be much grumbling at this part of the report, though the advisers have diplomatically softened it by charging the engineers of the Service with a corresponding bureaucratic spirit. To terminate this wardship and make the farmers self-dependent and self-reliant, it is declared that the water users must operate their works, a recommendation which all who know the situation are sure to support. And coupled with this declaration is a definite assertion of the state's responsibility for the care of a project located within it—a responsibility universally ignored until now. The engineers of the West have opportunity for public service in supporting these doctrines of community self-help and state co-operation.

Because it is thoroughly constructive, the report will be warmly welcomed on every hand. *Engineering News-Record* finds, in addition, a more personal satisfaction in noting that every substantial point of the report takes the same view, both as to fact and as to policy, that was represented in the reports of our own study of the situation last fall. The value of these reports, thus authoritatively acknowledged, was due wholly to the engineers of the West whose views were canvassed by our inquiries. It is their insight into the conditions and their analysis of causes that are now endorsed and approved by the Board of Advisers.

What remains to be done is perhaps the most difficult part of the reclamation problem. The appointment of Dr. Elwood Mead, a member of the Board of Advisers, to the headship of the Reclamation Bureau gives assurance that the remedies and new policies developed by the Board will at once find adoption, *so far as the existing law permits.* But this is by no means far; the greater part of the recommendations depends first of all on action by Congress, second on the support and approval of the states of the West. Therefore the advisers' report must be sold to the country at large and to its representatives in Congress. It must not be left to dusty files and forgetfulness like its predecessors, but must be discussed and agitated until its recommendations are carried into effect. We ask that engineers everywhere join in this work.

Drainage of California Stadium Playing Field

Extensive System of Tile Drains Designed for 24-Hour Precipitation Exceeding Annual Rainfall—Soil Studies Precede Choice of Material Overlaying Impervious Hydraulic Fill

By Walter W. Weir

Assistant Professor of Soil Technology, in Charge of Drainage, University of California, Berkeley, California

IN THE DESIGN and construction of the California memorial stadium at the University of California, completed last fall, particular precautions were taken to see that the field will never be too wet to play upon. The designers of the stadium, built only for football, were awake to the fact that its usefulness depended entirely upon the ability of the two universities, Stanford and California, to play their annual game in it. Although a number of games are played throughout the season, its seating capacity of 75,000 will be taxed, for a number of years at least, only at the Stanford-California game. As this occurs well past the beginning of California's rainy season, the necessity for a dry field is doubly important.

The stadium was erected in memory of Californians who gave their lives in the world war and is a combined earth-fill and reinforced-concrete structure built in the shape of an ellipse with axes of 759½ ft. and 567⅝ ft. between outside walls. The main entrance at the north end is 20 ft. wide and the entrance leading to the 48 seating sections of 72 rows each are 10 to 12 ft. wide. Access to the playing field is through six tunnels at field level. The work was begun in November, 1922, and was rushed through the entire construction period in order to be ready for the 1923 game. During about six months when the work was at its height the construction force averaged 260 men.

The California Memorial Stadium Commission deemed the provision of a satisfactory playing field sufficiently important to appoint a special investigating committee to prepare a report. This committee, composed of four members and each a specialist in his line, represented drainage, irrigation, soils and grasses. The report of this committee was adopted and written into the specifications for the construction of the stadium practically as submitted.

The stadium is built in a canyon on the university campus in such a position that the material for the playing field and much of the seat-bank construction was placed by the hydraulic fill method from material washed from one of the canyon walls. Strawberry Creek, which flows through the canyon, has a drainage area of less than two square miles and is practically dry except during the rainy period. The creek is now carried beneath the stadium in a concrete culvert as shown on the accompanying diagram. The canyon was filled to make the playing field of the stadium, to a depth of 14 ft. at the upper end and 24 ft. at the lower end above the original creek bed.

The playing field and seat banks were built up by the hydraulic fill method partly because of the minimum amount of shrinkage which would subsequently take place. The finest materials were included in the fill, making it about as impervious as is possible to obtain. The field has no crown so that any water falling upon it would remain. These two facts made necessary the installation of artificial drainage.

The total area occupied by the stadium is 354,000 sq.ft., 250,000 sq.ft. of which are included in the concrete-faced seat banks, and 104,000 sq.ft. inside the parapet, or that area constituting the playing field. The securing of an outlet for drainage was simple since the concrete culvert carrying Strawberry Creek was beneath the field; two outlets were provided just inside the parapet at either end of the field.

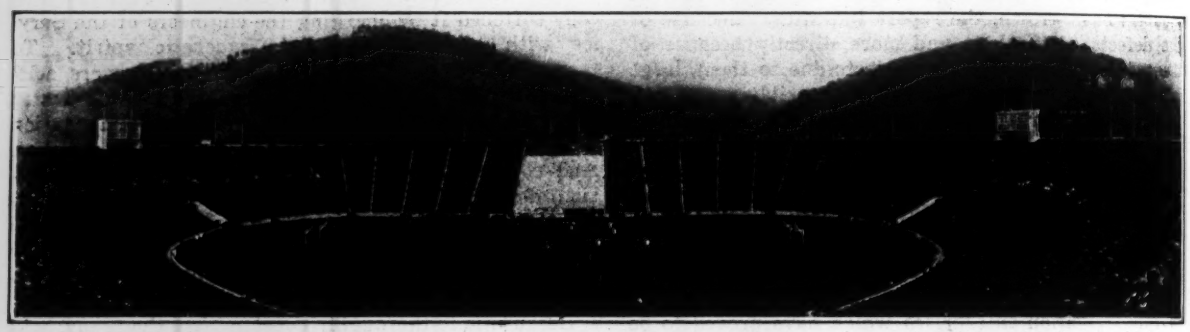


FIG. 1—CROWD AT UNIVERSITY OF CALIFORNIA—STANFORD FOOTBALL GAME, AT OPENING OF NEW STADIUM

Tile Drainage—As the field has no slope or crown two arbitrary high points along the parapet, one on either side of the culvert line, were chosen from which to run main drains to the nearest outlet. Beginning at each high point and running in both directions main

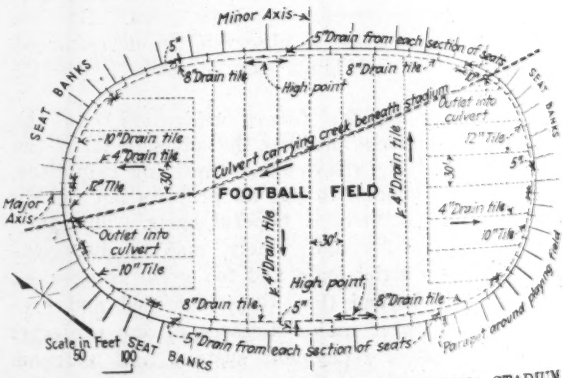


FIG. 2—TILE DRAINAGE LAYOUT, CALIFORNIA STADIUM

drains were thus located to surround the field a few feet inside the parapet. These drains, beginning in each case with 8-in. tile which increased to 10- and 12-in. size, were laid on a grade of 0.5 per cent. Each of the 48 sections in the seat banks is provided with a 5-in. tile running under the parapet and connecting with the main drain to take care of rain falling on the seats. It will be seen therefore that no drainage in the field itself need be provided to care for runoff from the seats.

Under-drainage for the field consists of lines of 4-in. tile spaced 30 ft. apart laid out as shown on the diagram. For the center and major part of the field, the drains run at right angles to the major axis of the stadium and slope both ways from this axis to the larger drains at the edge of the field. At either end of the field the drains run parallel to the major axis. The upper ends of each of these interior drains are at the same elevation and about 4 in. below the surface of the hydraulic fill. The grade was made uniform for all lines at 0.4 per cent. The longest interior drains, those two which are directly over the minor axis of the field, are about 125 ft. in length, giving a total fall to these lines of 0.5 ft. and a maximum depth at their outlet of about 0.9 ft. The upper ends of the drains were connected so as to facilitate the distribution of irrigation water should sub-irrigation be desired. The line connecting the upper ends of those drains, which are parallel to the major axis, has no slope.

Upon the completion of the drains as just outlined, the entire field, including the trenches above the tile, was covered with a 4-in. layer of crushed rock, followed successively with 4 in. of fine gravel, 4 in. of river sand, and finally 10 in. of soil. Thus the field is built up 22 in. above the impervious base upon which the tile are laid. Each layer of rock, gravel and sand was carefully smoothed, packed and levelled before the next layer was placed.

Laboratory Experiments—Before selecting the material for building up the field or determining the thickness of each layer, rather extensive laboratory studies were made. Twelve heavy galvanized tanks 18 x 24 x 20 in. were set up into which were placed varying depths of rock, gravel and sand, and various types of soil. At the same time, studies were made on both surface and sub-irrigation and on various grasses. Rock, gravel and sand from several sources were examined and screen analyses made. Selection of the particular material resolved itself into a choice of sizes which were thought to best suit the requirement of perfect drainage and give a minimum settlement of the surface soil by filtration. A sieve analysis of the crushed rock selected showed that 99.70 per cent was retained on a ¾-in. sieve, while only 4.3 per cent was retained on a 1-in. sieve, and most of it was between ¾ and 1 in. in maximum diameter. Sieve analyses showed that 98.7 per cent of the gravel passed through a ⅜-in. opening and only 3.4 per cent was retained on the ¼-in. sieve. The sand used was a coarse river sand. All of these materials were high grade and free from all soil or foreign matter.

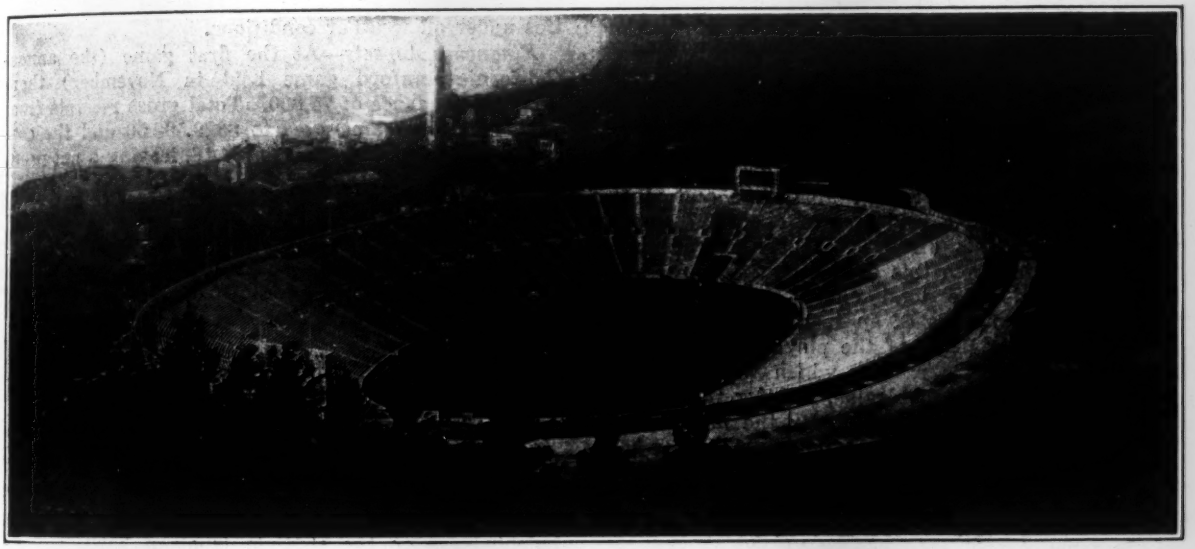


FIG. 3—STADIUM BUILT BY HYDRAULICALLY FILLING OVER CREEK BED IN CANYON

The selection of a suitable soil was given considerable attention and several samples were tested for rate of percolation, water holding capacity, fertility and other qualities. Soil from the stadium site or nearby on the campus could have been obtained much more cheaply than that which was used, but it was eliminated early in the investigations because of its tendency to puddle when worked under adverse moisture conditions. The matter of fertility, although important, was not a controlling factor as that could have been readily improved by the use of fertilizer.

The mixing of the local soil with peat and also with sand to improve its physical characteristics was considered, but the resulting mixture did not give satisfactory results under test. A soil known as Antioch fine sandy loam and occurring quite extensively in and about the city of Alameda was finally selected as being superior to any other examined. The soil is unusually fertile for one of its texture, it has body enough to withstand rough usage without shifting, and has excellent drainage properties. In the laboratory under compacting similar to that existing in the field, an 11-in. column of water passed through a 10-in. depth of soil in about 2½ hours. A similar depth of soil in one of the tanks after undergoing severe puddling and work-

ing while wet (a condition which will never be met even on a football field) permitted 2 in. of water to pass through it in about 2½ hours. This soil, classified by the U. S. Bureau of Soils method as a fine sandy loam, gave mechanical analysis sizes as follows:

Fine Gravel	Coarse Sand	Sand	Fine Sand	Very Fine Sand	Silt	Clay
2.–1 mm.	1.–.5	.5–.25	.25–.10	.10–.05	.05–.005	.005–
0.44%	3.66%	22.69%	53.85%	12.72%	4.04%	2.77%

The normal water holding capacity was about 25 per cent; the maximum water holding capacity was about 35 per cent; the moisture equivalent (amount held against a force = 1,000 gravity) = 13 per cent; and the wilting point (by Briggs formulas) = 7.65 per cent.

The commission was able to secure sufficient of this soil to cover the playing field to the desired depth of 10 in. (about 2.4 acre-ft.) by being permitted to do the grading work on two or three blocks of new street. The soil was hauled by truck from Alameda, through the business district of Oakland to the stadium field in Berkeley, about ten miles.

That excessive tile drainage has been provided is evident from the size of tile and the grade used. The longest one of the four main drains has a seat area of about 1.7 acres and a field area of about 0.7 acres to take care of. This drain is capable of carrying a runoff of 29 in. from this area each 24 hours, which amount exceeds the total annual rainfall for the region; and downpours of an inch per hour are very unusual. The condition of the playing field, however, is determined by the rate at which water will pass through the soil into the drains, and for the soil used this has been found by test under the most adverse conditions to be equal to approximately 1 in. per hour. Should a rain of this intensity occur immediately before a game, there will be other factors than the condition of the playing field which will govern the postponement of the game.

Irrigation and Sodding—The matter of irrigation was considered in the design of the sub-drainage system and the ends of the tile lines were connected so that the whole area might be readily sub-irrigated by closing the outlets into the culvert and backing water up through the drainage system. Although this method of irrigation was included, it was not recommended by the committee because of the excessive waste of water and the possibility of uneven distribution. Because of the low capillary power of the rock, gravel and sand layers, it would be necessary to raise the water table to the lower edge of the soil layer in order to give a thorough wetting of the entire soil mass. Assuming the void space as 30 per cent, it would require 3½ in. of water for each irrigation before any would reach the soil and be available for plant growth. This must be drained out after each application, if a permanent sod is desired. Surface irrigation by means of hose and sprinkler was recommended.

The matter of sod was also carefully considered by the committee and definite recommendations made. Because of the short time between the completion of the field and the first game, a quick growing grass was recommended for last year. Italian rye was therefore planted, but following the Stanford game this grass was taken out and the permanent slower growing grasses planted.

The following mixture was recommended:

Name	Species	Source of Supply	Per Cent of Each
Creeping Bent	Agrostis Stolonifera	Rhode Island or Germany	50
Colonial Bent	Agrostis Tenuis	New Zealand	10
Velvet Bent	Agrostis Canina	Rhode Island	10
Chewing Fescue	Festuca Saburicolo.	New Zealand	10
Kentucky Blue Grass	Poa Pratensis	Local	10
Meadow Blue Grass	Poa Trivialis	England or Germany	10

Estimated quantity, 1,000 lb.

Although the soil used on the field is known to be very fertile, and Alameda is noted for the excellence of its lawns, commercial fertilizer was used to promote a rapid and luxuriant growth of rye grass during the past season.

Members of the stadium commission and others who have seen the playing field, feel that the unusual effort spent at this time in a careful study of the details set forth will result in a field of unexcelled playing qualities under all weather conditions.

Financial Aspects—At the first game (the annual California-Stanford game held in November) there was an attendance of 75,000. Total gross receipts from paid admissions amounted to $329,508.50 and the cost of holding the game was $10,784.16, leaving a net profit on the event of $318,724.34.

Reduced to tabular form, the financial status of the stadium project on the day of the game was about as follows:

Total cost, including land, approximately		$1,400,000
Raised by selling unit subscriptions of $100 each, entitling subscriber to two selected seats at the annual Stanford-California football game, for the next 10 years	$1,100,000	
Campaign and stadium office expenses for two years	70,000	
	1,030,000	
Pledges outstanding, the last not due until 1928	230,000	
Applied upon indebtedness		800,000
Unpaid balance, approximately		$600,000

After deducting that part of the gate receipts that could be applied to this unpaid balance the remaining indebtedness on the stadium is about $500,000. All surplus income of the Associated Students will be applied on this indebtedness, and additional revenue is expected to be derived from the use of the stadium for fairs, conventions, and other large public gatherings. No money from state appropriations was used in this undertaking. Assurance of a California-Stanford game for the next ten years is given in a treaty between the two universities.

France May Harness Tides in Brittany

The French Senate is planning to give financial assistance to a project for the development of power by using the power of the tides where the Mare-mortice bars the estuary of the Aber-Vrach in Brittany. The principal plant will consist of a barrage 450 ft. long with four groups of turbines functioning under the double effect of the incoming and outgoing tide. The power thus generated will vary from 75 hp. to 1,200 hp., but when operated in connection with a regulating plant higher up the river it will be possible to produce a minimum constant output of 1,200 hp. and a maximum output of 3,200 hp. The tidal range in the estuary of the Aber-Vrach is approximately 25 ft. and the preliminary studies of the Société Financière pour l'Industrie and of the Société Technique pour l'Industrie indicate that there will be an annual output of 11,000,000 kw.-hr. Cost of plant is estimated at 28,000,000 francs.

Layout and Design Factors in a Tobacco Stripping Plant

Economical and Material Requirements—Arrangement to Suit Eight Steps in Process—Storage and Space Limitations Defined

By Clifford C. Muhs
Civil Engineer, Chicago

PROCESSES through which leaf tobacco passes from the grower's shed to the cigar maker's bench known as stripping, include several distinct steps upon the success of which the leaf merchant depends for the quality of the finished product. As the work is principally that requiring manual dexterity and only a small amount of mechanical equipment, but little thought has been bestowed on careful layout, which can not only assure the quality of the product through better control but very materially reduce the labor cost. Heretofore, the average of such operations under one supervision has been about 150 employees and the plant layout has generally grown in an even more haphazard fashion than is ordinarily found in factories. The recent tendency to increase the size of units in order to take advantage of convenient transportation and the best supplies of labor, together with the increasing cost and scarcity of the latter has given an opportunity for modern layout methods.

The Site—The location is chosen as near the center of density of tobacco culture in the section from which supplies are to be drawn as is practicable with rail or water transport (preferably) to clear the finished product to terminal warehouses. A siding or wharf is of little use, however, for the raw material is mainly carted direct from the plantations to the plant door.

The steps in the process are as follows: Receiving storage, steaming, wetting, stripping, blending, drying, bailing and finish storage.

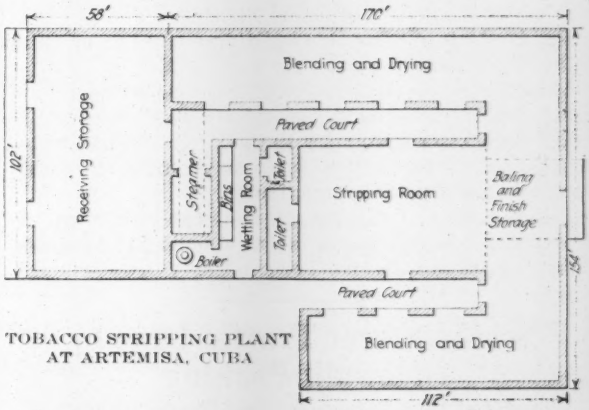
The stripping and drying are the two steps about which the plant should be designed, both by reason of the labor and plant expenditure involved and the length of time necessary for the operations.

As the work is seasonal, to a certain extent, design must be for a peak capacity, determining factors of which will be (1) the necessity for furnishing as nearly continuous work as possible in order to hold the labor and keep plant cost to a minimum, (2) clearing of the tobacco through the plant as rapidly as possible to minimize interest charges on goods in process of manufacture. Practically the whole crop passes from grower to leaf merchant in a period of six months and in a period including the succeeding three months 87 per cent of it has again passed out of the hands of the fabricator, thus necessitating operations on a half-time basis for the remaining three months.

Ground values being low, space is economically obtainable to make the plant of one story construction and, though inflammable product is handled, the saving in insurance rates through fire-resistant construction is not warranted. Wood or sheet-metal construction would be eliminated on account of high depreciation. Sheet-metal has the further disqualification of sweating on a cool night following a hot day, a thing which might easily cause serious damage in the drying sheds and storage warehouses. The choice of materials is thereby reduced practically to light masonry walls, concrete or brick floors and some form of durable roof cover on wood framing.

The tobacco arrives in receiving storage, which should be of a size to hold a six weeks' full time supply and be located at one end of the plant with space and unloading platforms for carts. As the bales are 32-in. cubes and of an average 80-lb. weight they may be piled to any convenient height without materially adding to the labor cost; six bales is a common height.

The steaming and wetting, being closely joined and the only steps in which moisture is needed, may well be housed together between receiving storage and stripping room. Steaming is done to obviate breakage of leaf on opening the bales and as 24 hours are required for the process the steamroom should accommodate enough bales for a maximum day's stripping. A good type of steamroom is one with a small boiler room at one end, the steam being led through manifolds to a



TOBACCO STRIPPING PLANT AT ARTEMISA, CUBA

perforated pipe grid in the pit over which stand the platform cars. The construction of the steam chamber itself may be similar to that customarily employed in dry kilns, that is, with cars running on broad-gage track supported on piers of a height to give working space under the cars and an insulated door of any convenient form for operation.

Passing into the wetting room the bales are broken out and inspected prior to wetting. Wetting bins should be of a size to hold a bale of leaf and preferably of concrete with a hand-operated drain to an open gutter discharging through a well-screened opening into a sewer. Concrete bins are preferred to wood due to rapid rusting out of nails, bolts and other hardware. Open gutter drainage is preferable due to the large amount of broken leaf necessitating frequent cleanings. A space 12 to 15 ft. wide should be provided on the operating side of the bins with a drainage slope to the gutter along the bins as the operators on taking the hands out of the bins free them of water by a long swinging shake and throw them backward clear of the alley.

In the stripping room fair light and good ventilation are the main points, the building itself being so situated as to have easy access to the drying rooms and of any convenient shape and column spacing as the stripper's equipment consists only of chair, small table and two baskets. Having arrived at the maximum length of time over which full-time operation may be economically extended together with the annual amount to be handled, the size required is easily determinable

with the two remaining factors, average daily output per person and space per person, say, 15 sq.ft.

As the following operation of blending requires comparatively small space and only one-third of the time (4 to 5 days) needed for drying, it may conveniently occupy the alleyways between the freshest trays in the dryers. The process consists in loosely packing the newly stripped and still wet hands in ventilated barrels and allowing the blending to proceed for a length of time suited to atmospheric temperature and moisture.

This brings us to the consideration of dryers, which form by far the largest part of plant cost. About 28 sq.ft. of floor space will be required per stripper with ten tiers of trays in the racks as the convenient limit of reach, and an average drying time of 14 days. These trays may vary in size around a mean of 3 x 5 ft., and will be double-banked with alleyways of sufficient width (4½ ft. for a 3-ft. tray) between. In order to attain the even drying so essential to good quality the plan of the drying-room should be narrow and this will probably mean ranging this building along two or more sides of the stripping-room for accessibility.

Rebaling is accomplished with an adaptation of the usual baling press and, as the finished product is usually despatched promptly to the large terminal warehouses, but small storage space is required, a week's output being a probable maximum.

For the sake of illustration the plan shows an exceptionally compact plant recently built in Artemisa, Cuba, for the Mendelsohn Tobacco Co.

Widen Street Traffic Lane by Sidewalk Parking

Suggested Plan for Increasing Traffic Space on Streets With Wide Sidewalks and Building Set-Back

By J. Rowland Bibbins
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IN VIEW of the tremendous demand in cities for legitimate parking space to permit customers to reach banks and stores for the ordinary transaction of business—quite apart from the need of long-time day storage for office people—it seems the better part of wisdom to put to work some of the useless sidewalk and building set-back space and thus increase the traffic capacity of the roadways. This can be done in many of the wide streets of Washington and other cities without incurring the expense even of changing curbs. The plan is indicated by the accompanying illustration.

Instead of parallel parking and the irregular habit of drivers leaving their cars at all angles, the car is run up onto the present sidewalk at right angles until the rear wheels line up at the present curb. This will automatically standardize all parking which would not be the case if the curb were removed. The rear overhang on modern-size cars is fairly standard—around 30 or 36 in. For cars of the Ford type, which are in the vast majority, the overhang is still less; occasionally a long car, with double rear tires, overhangs more. As a general average, however, this change in parking alone will add about 3 ft. to each side of the street.

Many streets needing relief happen to have roadways just too narrow to accommodate an extra traffic line. The new plan would provide that traffic line by the addition of 3 ft. on each side. Thus on a 30-ft. total roadway, the net usable traffic way with parallel parking on each side becomes 24 ft. or practically a two-line traffic street. A 30-ft. net traffic way obtained by the new plan of parking would give ample space for three lines of traffic, two lines one way in the morning and reversed two lines in the evening, thus doubling the present street capacity for rush-hour traffic. With a 40-ft. roadway and this new system of parking, the net traffic way will be 35 ft., accommodating four lines of traffic, two in each direction on a two-way street or three on a reversible plan above mentioned.

Side parking uses up 6 ft. on each side with an average car spacing of 16 ft., accommodating 330 cars per mile of curb each side, and using 32,000 sq.ft. of pavement area per mile. Angle parking uses 14 ft. of the roadway with an average 11-ft. spacing of cars, accommodating 470 cars per mile and using 72,000 sq.ft. of pavement per mile. The new plan of parking uses only 3 ft. of the roadway with an average spacing of 7½ ft., accommodating at the maximum 700 cars per mile and using only 15,800 sq.ft. of pavement area per mile, the balance, 52,500 sq.ft. per mile, being taken from the excess sidewalk space. Of course the actual parking capacity here depends somewhat upon the spacing of the trees, but it is clear from the above that the new plan of parking will nearly double the capacity of the present side parking plan and use only half of the pavement area at present used. And it will give close to fifty per cent more parking capacity than the angle parking and use less than one-fourth the pavement area.

CAR ON PARKING STRIP INSIDE CURB

This method gives 75 to 100 per cent more parking space, 40 to 100 per cent more traffic way, and standardized parking lines. The car is entered from the sidewalk, and there is plenty of sidewalk left. The curbs need not be disturbed. The parking to be of gravel, as trees will die if paved over.

States Share National Forests Road Fund

Twenty-nine states in which national forests are located will share in the distribution of the $1,000,000 fund appropriated by Congress annually for the construction of roads and trails within the national forests and apportioned by the Chief of the Forest Service and the Secretary of Agriculture. This particular fund is expended only under co-operative agreements with state authorities. The states benefited this year are: Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Idaho, Maine, Michigan, Minnesota, Montana, Nebraska, Nevada, New Hampshire, New Mexico, North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Utah, Virginia, Washington, West Virginia, Wyoming. Alaska and Porto Rico are also included.

New Method of Computing Backwater and Drop-Down Curves

Modification of Channel Sub-Division Method with Elimination of Trial Calculations—Applicable to Canals, Sewers, Etc., Under Uniform Hydraulic Conditions

By Alva G. Husted
Assistant Sanitary Engineer, County of Cuyahoga, Cleveland, Ohio.

THERE has been much recent discussion in our technical societies and the technical press concerning the calculation of backwater and drop-down curves. Practically all of these discussions may be placed in one of the following two classes: (1) Theoretical formulas for regular channels and (2) trial-and-error methods for any channel. The theoretical formulas derived for the solution of such problems are too mathematical and too complex to afford the average engineer a ready basis of application to practical problems, while the trial-and-error method is long and laborious in that it involves dividing the channel into a number of reaches, and often requires the making of several trial computations for each reach.

For assisting the solution of backwater problems in accordance with the theoretical method mentioned above, tables of backwater functions have been developed. Bresse ("Cours de Mechanique Appliqué") has worked out such a set of backwater functions which give theoretically correct results for rectangular channels only. Ruehlmann ("Hydromechanik") has worked out another set of backwater functions. These are much simpler of application than Bresse's backwater functions but are only approximately correct. They, too, are applicable to rectangular channels only. Many textbooks on hydraulics give these tables of backwater functions and illustrate their use by means of calculations upon a natural stream or other irregular channel. This is a dangerous procedure in that the reader may be led to think that the functions are correct for any channel.

The method of subdividing the channel into relatively short reaches and computing each reach separately has the merit of simplicity and does not involve the use of tables of backwater functions. As ordinarily applied it involves making trial calculations, since the depth and consequently the cross-sectional area at only one end of the reach is known. The depth at the other end is assumed and the resulting slope calculated, but unless the calculated slope happens to correspond to the assumed depth, other assumptions will have to be made until the correct assumption is found. This method is probably the simplest and best for use in computing backwater and drop-down curves in irregular channels such as natural streams.

Trial Calculations Eliminated—The object of this article is to describe a method which is similar to the method just described but which eliminates the necessity of making trial calculations. The method here given also affords criteria by which it can be determined whether the resulting curve under given conditions will be of the drop-down or backwater type, while if a standing wave occurs, its height and location can also be determined. It can not be applied to irregular channels, such as natural streams, but for canals, sewers, etc., it affords a method that is relatively simple in operation and is theoretically correct to any desired accuracy.

The method differs from that ordinarily used in that the depths at the two ends of the reach are assumed and the calculation is made to determine the length of the reach, as in the case of the theoretical backwater formula. This method of solution is not so disadvantageous, in comparison with the ordinary method of slope calculation where the length of reach is assumed in the first instance, as might at first be thought, since the method affords a ready means of developing the backwater curve from which the depth at any distance upstream from the dam or reservoir can readily be determined.

In the examples given, a channel of uniform trapezoidal cross-section is assumed. As stated above, the method is not adapted to cases of natural streams or

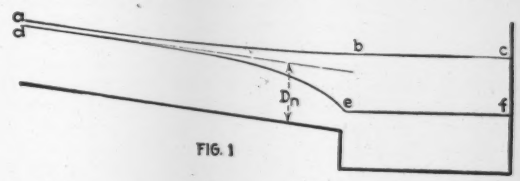


FIG. 1

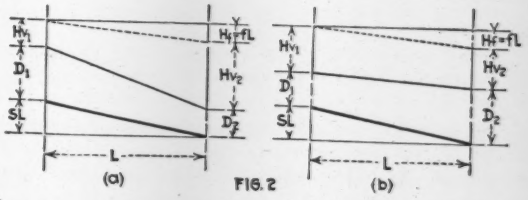


FIG. 2

FIG. 1—BACKWATER AND DROP-DOWN CURVES
FIG. 2—RELATION OF TOTAL HEAD AT TWO GIVEN POINTS

other channels of widely varying cross-section for the reason that when the cross-section of a channel varies considerably its average hydraulic elements throughout a given reach can only be approximated if the length is undetermined, and this introduces the necessity for trial calculations. In such cases it is better to divide the stream into reaches, and by means of trial calculations determine the depth at the end of each reach, in accordance with the method ordinarily given in textbooks on hydraulics.

The method herein given was developed in conjunction with a study of the amount of channel storage available between different levels in a conduit leading into a reservoir, and this problem is well adapted to illustration of its use, since it affords examples of the occurrence of both backwater and drop-down curves in the same channel with different levels of the reservoir.

Incidentally, the problem of determining channel storage with fluctuating levels is of importance in a number of lines of hydraulic investigations, such as the relative magnitude of floods at different locations along a stream, the maximum discharge at a sewer outlet resulting from heavy rainfalls near its source, or the maximum avail-

able supply from a water-works or irrigation reservoir supplied by a long open channel or conduit.

Notation—The notation used throughout this discussion is as follows:

A = area of cross-section of water in channel.
D = depth of water in channel.
D_1, D_2, etc. = depth of water at points 1, 2, etc.
D_n = normal depth.
D_c = critical depth.
R = hydraulic radius.
f = friction loss per foot.
H_f = total friction loss in reach under consideration.
s = slope of channel or conduit.
n = coefficient of roughness.
g = acceleration due to gravity.
V = velocity of flow.
V_c = critical velocity.
H_v = velocity head.
B = width of surface of water.
L = length of reach under consideration.
Q = discharge in cubic feet per second.
P = total hydrostatic pressure in pounds on plane perpendicular to flow.
w = weight of 1 cu.ft. of water.

Definitions—In order that there may be no misunderstanding as to the meaning of certain terms used herein, the following definitions are given:

Normal Depth is the depth of flow at which the friction loss per foot exactly equals the slope of the invert of the channel.

Critical Depth at any cross-section is the depth at which for a given discharge the depth plus velocity head is a minimum. In other words it is that depth at which an infinitesimal increase in depth will cause an equal infinitesimal decrease in the velocity head or vice versa.

A *Backwater Curve* is the profile of the surface of a stream when the depth of flow is greater than the normal depth. (See Fig. 1.)

A *Drop-down Curve* is the profile of the surface of a stream when the depth of flow is less than the normal depth. (See Fig. 1.)

At the outset it will be necessary to accept Bernoulli's theorem as the application to hydraulics of the law of conservation of energy. Expressed in a simple manner this states that the total head (static head plus velocity head) at one point in a channel or conduit is equal to the total head at any other point in the channel plus (or minus) the friction loss between the two. This is illustrated graphically in Fig. 2. In this illustration it will be noticed that

$$H_f = sL + (D_1 + H_{v_1}) - (D_2 + H_{v_2}) \qquad (1)$$

Changing signs and transposing we have

$$sL - H_f = (D_2 + H_{v_2}) - (D_1 + H_{v_1}) \qquad (2)$$

Substituting for H_f its value, fL, and for $(D_2 + H_{v_2}) - (D_1 + H_{v_1})$ the term $\Delta(D + H_v)$, we have the equations

$$sL - fL = \Delta(D + H_v) \qquad (3)$$

and

$$L = [\Delta(D + H_v) \div (S - f)] \qquad (4)$$

It will be noticed that the term $\Delta(D + H_v)$ represents the increase in the value of $D + H_v$ going downstream. In other words if $D + H_v$ is greater at the upper end of a given reach than at the lower end, $\Delta(D + H_v)$ is a negative quantity.

From equation (4) the distance between sections (length of reach) can be determined in a channel of any uniform section and slope if we have given the cross-section of the channel, the coefficient of roughness, the quantity of water flowing, the slope, and the depth at each end. The value of f is computed from any convenient flow formula, using for V the mean of the end velocities and for R the mean of the end hydraulic radii. This will give results sufficiently accurate if the difference in end areas is taken relatively small.

Two Problems by Way of Illustration—To make the method of solving backwater and drop-down curves as clear as possible two problems are herein given together with their complete solution. It is believed that the data in these two problems are so general that the methods used will be applicable to any problem involving backwater or drop-down curves, providing the channel or conduit is of uniform cross-section throughout the length considered. Because of certain conditions it has been found advisable to separate all problems of this nature into two cases. Case I includes all problems in which the normal depth of flow is greater than the critical depth; Case II, all problems in which the normal depth of flow is less than the critical depth.

Under Case I it is possible to have both backwater curves and drop-down curves but under Case II it is possible to have only backwater curves. Furthermore, any backwater curve under Case II is not a continuous curve but is interrupted by an hydraulic jump. Care must be used in solving the backwater curve under Case II on account of this interruption in continuity. The method of locating the hydraulic jump will be given in the solution of the problem under Case II.

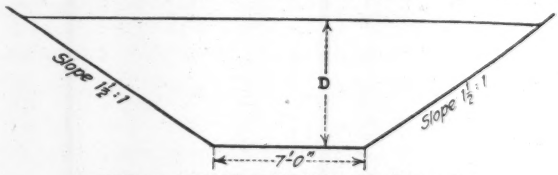


FIG. 3—CROSS-SECTION OF CHANNEL

The critical depth can be determined by plotting various values of $D + H_v$ as ordinates against the corresponding values of D as abscissas. The depth which gives a minimum value for $D + H_v$ is the critical depth. If, however, it is only desired to know whether D_n is greater than or less than D_c, in other words whether a given problem lies in Case I or Case II, a convenient method is as follows:

If for normal depth $A/2B$ is greater than H_v then D_n is greater than D_c and the problem lies in Case I.

If for normal depth $A/2B$ is less than H_v then D_n is less than D_c and the problem lies in Case II.

Fig. 3 shows the channel selected for the problems in this discussion. This is a trapezoidal section, but any other section, regular or irregular, would apply equally well so long as the section and slope were uniform throughout the length considered.

Manning's formula ($V = \frac{1.486}{n} R^{m} f^{\frac{1}{2}}$) is the flow formula used throughout this discussion. The coeffi-

TABLE I—TABULATION OF BACKWATER CURVE COMPUTATIONS: CASE I

1 D	2 A	3 R	4 V	5 H_v	6 $D+H_v$	7 $Av.R$	8 $Av.V$	9 f	10 $\Delta(D+H_v)$	11 L
7.0	122.5	3.80	1.22	0.02	7.02					
						3.69	1.30	0.00008	0.49	534
6.5	108.9	3.58	1.38	0.03	6.53					
						3.47	1.47	0.00012	0.49	557
6.0	96.0	3.36	1.56	0.04	6.04					
						3.24	1.68	0.00017	0.49	590
5.5	83.9	3.13	1.79	0.05	5.55					
						3.01	1.93	0.00024	0.48	631
5.0	72.5	2.90	2.07	0.07	5.07					
						2.78	2.25	0.00037	0.48	762
4.5	61.9	2.67	2.42	0.09	4.59					
						2.55	2.65	0.00057	0.46	1,070
4.0	52.0	2.43	2.88	0.13	4.13	....	....	.....	.....	.....
Total length										4,144

cient of roughness, n, is taken at 0.025. The formula then reduces to $V = 59.44\ R^{\frac{2}{3}} f^{\frac{1}{2}}$. It will be noted that instead of the symbol s, as usually given for the slope, we have used f, representing friction loss per foot of length. Where the flow is uniform (unchanging velocity) the friction loss per foot is exactly equivalent to the slope. Since in this discussion we are dealing with non-uniform flow, it was thought best to substitute friction loss for slope in the formula so that friction loss and slope would not be confused one with the other. Any of the flow formulas in common use could have been used in place of the Manning formula, although Kutter's formula has a slight disadvantage in that the coefficient C is a function of the slope as well as of the hydraulic radius. This disadvantage can be overcome, however, by the use of curves plotted from Kutter's formula. Bazin's formula or Williams and Hazen's formula can be used as conveniently as Manning's formula in this method.

TABLE II—TABULATED COMPUTATIONS FOR CRITCAL DEPTH

D	A	V	H_v	$D+H_v$
1.0	8.50	17.64	4.83	5.83
2.0	20.00	7.50	0.87	2.87
3.0	34.50	4.35	0.29	3.29
4.0	52.00	2.88	0.13	4.13
1.9	18.71	8.01	1.00	2.90
2.1	21.31	7.09	0.77	2.87
2.2	22.62	6.62	0.68	2.88
2.3	24.03	6.24	0.60	2.90

Case I—As an example illustrating the solution of problems under Case I the following problem is given:

In a canal having a cross-section as shown in Fig. 3, with a slope of 1 ft. per 1,000, the flow is 150 sec.-ft. The elevation of water in the storage basin into which the canal discharges is allowed to fluctuate between points 1 ft. and 7 ft. above the bottom of the canal at its lower end. Required the profile of the water surface in the last 3,000 ft. in the canal under maximum and minimum conditions.

The first step in a problem of this nature is to determine whether the problem comes under Case I or Case II, i.e., whether the normal depth is greater or less than the critical depth. As stated above, a convenient method to do this is to determine whether $A/2B$ is greater or less than H_v at normal depth. To do this we must first determine the normal depth. This can be done by assuming surface slopes parallel with the channel bottom and computing the discharge for several different channel depths. The depth corresponding to the required discharge (normal depth) can be determined by direct or graphical interpolation. In this problem the normal depth determined by Manning's formula with the value of n as 0.025 is found to be 3.7 ft. for the required discharge of 150 sec.-ft. For a depth of 3.7 ft. $A/2B = 1.28$ and $H_v = V_2 \div 2g = 0.16$. Therefore D_n is greater than D_c, and the problem lies in Case I. There is possible, then, a drop-down curve as well as a backwater curve, and the backwater curve is continuous—contains no hydraulic jump.

Having determined that the problem lies in Case I, the next step is to make the main computations. It will be noted that the maximum depth at the lower end is 7 ft. and the normal depth is 3.7 ft. Table I gives a tabulation of the computations for the backwater curve beginning at the lower end of the canal, taking reaches having intervals in depth of 0.5 ft.

Since it is necessary to start with a section of known depth, the outlet end will be the point of beginning. The first depth, therefore, in column 1 is 7.0 ft. Using intervals in depth of 0.5 ft. the second quantity under column 1 must be 6.5 ft. The first quantities given in columns 7 and 8 are obtained by averaging the values of R and V for the 7-ft. and the 6.5-ft. depths. Values in column 10 are obtained from the flow formula, using the values of R and V given in columns 7 and 8. The quantity $\Delta(D + H_v)$ given in column 10 is the difference between successive values of $D + H_v$ given in column 6, and, since the downstream value is the greater, the difference is positive. The length of reach, L, is computed from equation (4).

Having determined the backwater curve in the canal at maximum elevation, the next part of the problem is to determine the backwater curve at minimum elevation. According to the statement of the problem, the minimum elevation of water in the storage basin is 1 ft. above the bottom of the canal at the outlet. This does not necessarily mean that the elevation of water in the canal at the lower end is 1 ft. Indeed, a simple calculation will show that this could not be. Assume the depth at the lower end as 1 ft. Since the normal depth is 3.7 ft., there would be some point above the lower end at which the depth would be 1.5 ft. $D + H_v$ for 1-ft. depth is 5.83, and for 1.5-ft. depth is 3.31. $\Delta(D + H_v)$, then, is 2.52 and is positive (increasing downstream). But $L = \Delta(D + H_v) \div (s - f)$ and it can be seen without making the computation that f must be greater than s for any depth less than the normal depth. L, therefore, is a negative quantity. This is interpreted to mean that there can be no reach in which the depth is reduced from 1.5 ft. to 1.0 ft. Since $s - f$ is a negative quantity for all values of D up to D_n, L can be positive for values of D less than D_n only when $\Delta(D + H_v)$ is negative. $\Delta(D + H_v)$ is negative for decreasing values of D only when the values of D are greater than D_c. The critical depth is, therefore, the minimum depth to which the drop-down curve can fall. The critical depth in this case is determined by means of the computations in Table II.

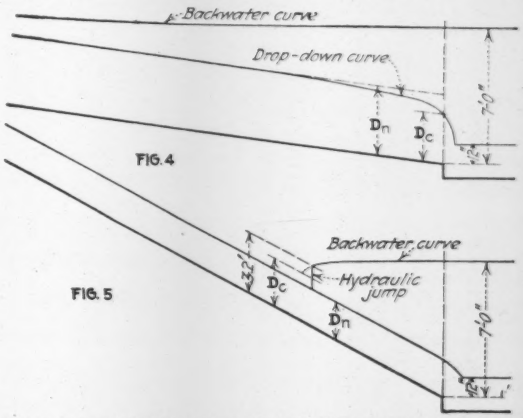


FIG. 4—BACKWATER AND DROP-DOWN CURVES—CASE I.
FIG. 5—BACKWATER CURVE—CASE II

By means of the first four computations in Table II it is seen that the critical depth is in the vicinity of 2 ft., since the value of $D + H_v$ is greater for both smaller and greater depths. By means of the remaining computations it is found that the critical depth is between 2 and 2.1 ft., say 2.05 ft. This, then, is the minimum depth of water that can occur in the canal at the lower end.

Since the depth at the outlet is less than the normal depth, the depth of water increases as we proceed up-

stream, and the profile of the water surface is a drop-down curve. The computations for this drop-down curve are tabulated in Table III, from which it appears that the normal depth (3.7 ft.) is reached at a distance of 2,589 ft. from the outlet. Theoretically this could not be, since the normal depth is an asymptote to the drop-down curve, and is not reached except at an infinite distance from the outlet. The drop-down curve approaches the asymptote so rapidly, however, that for all practical purposes the normal depth is reached at this point. It is obvious that the depth above this point is constant and equal to the normal depth. Fig. 4 shows the backwater curve and the drop-down curve as computed in the foregoing example.

Case II—To illustrate the solution of problems under Case II the same problem is used with the exception that the slope is 0.015 instead of 0.001.

As in Case I the first step is to determine the normal depth. This is computed in the same manner as was done under Case I, and is found in this case to be 1.8 ft. The critical depth is independent of the slope, and is 2.05 ft. as was stated under Case I. The normal depth is therefore less than the critical depth, and the problem lies in Case II. According to a previous statement, therefore, there can be backwater curves, but no drop-down curves. Furthermore, any backwater curve that occurs will contain an hydraulic jump. Table IV gives a tabulation of computations for the backwater curves under Case II.

TABLE III—TABULATION OF DROP-DOWN CURVE COMPUTATIONS: CASE I

1 D	2 A	3 R	4 V	5 H_v	6 $D+H_v$	7 $Av.R$	8 $Av.V$	9 f	10 $\Delta(D+H_v)$	11 L
2.05	20.65	1.43	7.26	0.82	2.87					
						1.49	6.84	0.0078	0.02	3
2.25	23.34	1.54	6.43	0.64	2.89					
						1.61	6.00	0.0054	0.09	23
2.50	26.87	1.68	5.58	0.48	2.98					
						1.74	5.24	0.0037	0.14	75
2.75	30.59	1.81	4.91	0.37	3.12					
						1.87	4.63	0.0026	0.17	101
3.00	34.50	1.94	4.35	0.29	3.29					
						2.00	4.12	0.0019	0.19	211
3.25	38.59	2.06	3.89	0.23	3.48					
						2.12	3.69	0.0014	0.21	502
3.50	42.87	2.18	3.50	0.19	3.69					
						2.23	3.36	0.0011	0.17	1,700
3.70	46.43	2.28	3.23	0.16	3.86					
Total length										2,589

It will be noted that the computations are carried to the point at which the critical depth is reached. If the computations were extended for points below the critical depth, the values of L would be negative, since the values of $\Delta(D + H_v)$ would then be negative. Therefore, the backwater curve can not cross the critical depth. Fig. 5 shows the backwater curve as computed in Table IV.

Since a smooth backwater curve cannot be extended to meet (or even approach) the normal depth, it is evident that sudden change, such as an hydraulic jump, must occur. The problem then is to determine the location of the hydraulic jump. At first thought it might appear that it would occur at the point where the backwater curve, as computed above, reaches the critical depth. However, we shall presently see that this is not the case.

According to Newton's second law of motion the rate of change of momentum must equal the force producing the change. If V_1 is the velocity immediately before the jump, V_2 the velocity immediately after the jump, P_1 the hydrostatic pressure acting on a plane perpendicular to the flow just above the jump, and P_2 the hydrostatic pressure acting on a plane perpendicular to the flow just below the jump, then

$$[(Q\,w\,V_1) \div g] - [(Q\,w\,V_2) \div g] = P_2 - P_1 \quad (5)$$

Transposing, we have

$$P_1 + [(Q\,w\,V_1) \div g] = P_2 + [(Q\,w\,V_2) \div g] \quad (6)$$

$P + [(Q\,w\,V) \div g]$ (pressure plus momentum) for the normal depth (1.8 ft.) is equal to 3,420. Therefore the depth to which the hydraulic jump will reach on the downstream side must likewise have a value of 3,420 for its "pressure plus momentum." A few trials will determine the depth on the downstream side to be 2.4 ft. All computations for depth less than 2.4 ft. in Table IV are, therefore, superfluous. Similarly, the dotted portion of the backwater curve in Fig. 5 can not exist.

TABLE IV—TABULATION OF BACKWATER CURVE COMPUTATIONS: CASE II

1 D	2 A	3 R	4 V	5 H_v	6 $D+H_v$	7 $Av.R$	8 $Av.V$	9 f	10 $\Delta(D+H_v)$	11 L
7.00	122.5	3.80	1.22	0.02	7.02					
						3.69	1.30	0.00008	0.49	32.8
6.50	108.9	3.58	1.38	0.03	6.53					
						3.47	1.47	0.00012	0.49	32.9
6.00	96.0	3.36	1.56	0.04	6.04					
						3.24	1.68	0.00017	0.49	33.0
5.50	83.9	3.13	1.79	0.05	5.55					
						3.01	1.93	0.00024	0.48	32.5
5.00	72.5	2.90	2.07	0.07	5.07					
						2.78	2.25	0.00037	0.48	32.8
4.50	61.9	2.67	2.42	0.09	4.59					
						2.55	2.65	0.00057	0.46	31.9
4.00	52.0	2.43	2.88	0.13	4.13					
						2.30	3.19	0.00095	0.44	31.3
3.50	42.9	2.18	3.50	0.19	3.69					
						2.06	3.93	0.00167	0.40	30.00
3.00	34.5	1.94	4.35	0.29	3.29					
						1.87	4.63	0.00264	0.17	13.7
2.75	30.6	1.81	4.91	0.37	3.12					
						1.74	5.24	0.00371	0.14	12.4
2.50	26.9	1.68	5.58	0.48	2.98					
						1.61	6.00	0.00540	0.09	9.4
2.25	23.3	1.54	6.43	0.64	2.89					
						1.49	6.84	0.00778	0.02	2.8
2.05	20.6	1.43	7.26	0.82	2.87					

Conclusion—It is believed that the above cases will cover any condition of backwater and drop-down curves that may be met within a channel or gravity conduit, providing the section, grade and coefficient of roughness are uniform throughout the length considered. Furthermore, the methods used can be applied to channels or conduits having breaks in grade by considering each grade separately.

Care should be taken in selecting the interval by which the depth is increased or decreased between sections. If the interval is too great the computed length of reach will be in error. A convenient method of determining whether or not the interval is too great is to re-compute the reach using two intervals of depth instead of one; e.g., in Table I the first reach has an interval of depth of 0.5 ft. (7 to 6.5 ft.) and the length of the reach is computed to be 534 ft. By dividing this section into two reaches having 0.25-ft. intervals of depth, the lengths of the reaches thus obtained are computed to be 261 ft. and 275 ft. respectively, and the sum is 536. The difference between 534 and 536 is well within the limit of accuracy of the flow formulas, and, therefore, the 0.5-ft. interval is sufficiently small.

Railway to Australia's Capital

A 40-mile railway is to be built from Yass, on the New South Wales Government Railways, to Canberra, the new federal capital city of Australia. Of this length, 30 miles will be built by the railway department of New South Wales and the remainder by the railway department of the Commonwealth, or federal government, the city being in an independent territory, similar to the District of Columbia. This new line will be of standard gage and is estimated to cost $2,500,000.

Wisconsin Theater Collapse Due to Faulty Work

Divided Responsibility, Careless Work and Lack of Inspection Seem Combined Cause—Steel Truss Design Involved

IN AN inquiry on the failure of a new theater building at Janesville, Wis., the coroner's jury distributed the responsibility between the design, construction and inspection. There was also apparent division of authority between the architect, owner and various contractors. This building, when nearly completed, collapsed on Sept. 18, 1923, resulting in the death of one man.

One of the failed trusses of the roof was illustrated in *Engineering News-Record* of Jan. 17, p. 105, and its failure was charged to the eccentricity of the heel joint. The correctness of this explanation was subsequently disputed, and the facts brought out in the investigation do not support the view that the trusses failed.

Official investigation gave the masonry construction as the cause of the accident, as shown by the following quotation from reports of the Wisconsin Industrial Commission, issued by the State Department of Engineering.

Since the collapse of the new Saxe Theater, Janesville, Wis., on Sept. 18, 1923, hearings before a coroner's jury have been held for the purpose of determining cause and placing responsibility. On Dec. 28, 1923, the coroner's jury rendered a verdict, the import of which was as follows: The Saxe Theater collapsed because of faulty walls, which faulty construction was due mainly to insufficiency of the state building code. There was insufficient inspection by the local (Janesville) inspection department and also insufficient inspection by the state department.

The Building Division investigated the collapse of the theater immediately after it occurred. There were no serious deficiencies in the design, except as pointed out below. The details of the collapsed structure were gone over very carefully in the search for a cause. The main part of the structure was 60 ft. wide by 120 ft. long. The walls were of Chicago common brick, 12 in. in thickness, with piers 17 x 29 in. (including wall thickness), supporting roof trusses at points 21 ft. 18 in. apart. The height of walls was 28 ft. The roof was of reinforced concrete 3½ in. in thickness, supported by steel roof trusses. The collapse of the roof was complete, which in turn pushed out one entire side wall and the truss bearing portion of the other side wall. The stage and entrance ends were left almost intact.

The five trusses were braced longitudinally by cross-bracing and by steel purlins at panel points. The north wall of the penthouse was supported by a 12-in. brick wall built directly on the sloping top chord of the south truss, the only resistance to sliding being the west wall construction and the three purlins extending northward. Plans showed this wall was to be of 9-in. concrete. The collapse of the roof was progressive, the reinforced-concrete roof slab coming down as a large wave from the south end. In

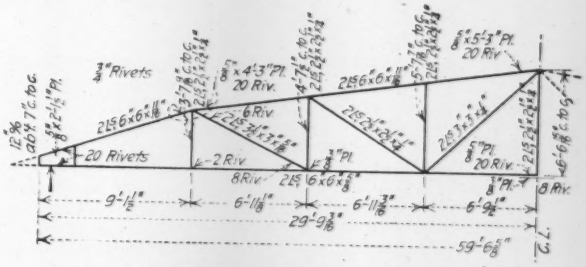


FIG. 1—DESIGN OF END TRUSS OF THEATER

the piers the brick were laid in cement which had become well hardened. For the walls between piers a combination of cement and lime mortar was used in varying proportions, as shown by the difference in color and hardness of the mortar, some of which was even washed off the brick during a rainstorm several days after the collapse.

Roof trusses had no signs of failure due to over stress in their original position, but some were very badly damaged in the fall. Rivets and connections, however, were in good shape. An analysis of the stresses due to total load shows that reinforced concrete and steel was not over stressed. The reaction at the west end of the south truss [the first to give way, see Fig. 3—EDITOR] was carried by a ⅜-in. steel bearing plate 13½ x 24 in. But the method of transmitting the truss load to the wall was such as to produce peculiar and excessive stresses in the masonry. The steel bearing plate was so placed that only the outer edge, not exceeding 2 in., rested on the brick masonry; the remaining center portion of the plate rested on the concrete block and mortar fill. The difference in hardness and elasticity of the two materials would cause all of the reaction to be transmitted to the concrete block. All bearing plates were the same, but the plate at the west end of the south truss was inadequate for the heavier loading at that point.

The outstanding questionable feature in the construction was the method in which the load of the trusses was transmitted to the brick masonry. Plans called for the placing of these trusses directly on brick piers built into the 12-in. brick wall, with steel bearing plates to distribute the load from the truss to the brick. Instead, cavities were left in the tops of these brick piers. These cavities were approximately 8 x 20 in. in size, with 4 in. of brick on each side, and extended 20 in. below the bearing plate. The anchor U-bolts were then set in the cavity which was then filled with concrete. The trusses and bearing plates were set directly upon these combination brick and concrete pier tops. The insertion of concrete filling under the truss bearings was not discovered until after the collapse. Apparently

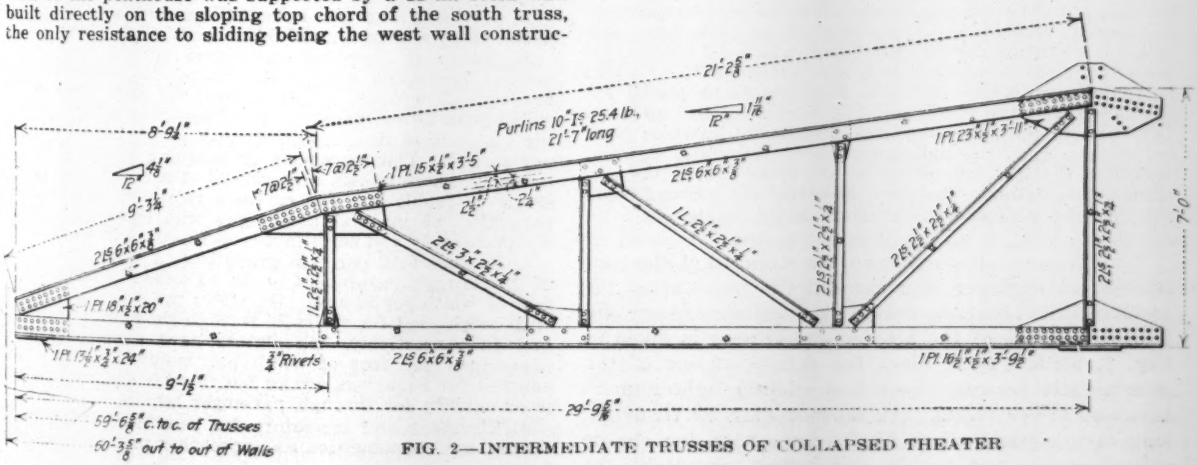


FIG. 2—INTERMEDIATE TRUSSES OF COLLAPSED THEATER

no inspector visited the job during the time that the tops of the piers were being finished, and this portion of the work was very soon hidden from view.

The truss at the stage or south end of the building supported on the west half of the truss a reinforced-concrete and masonry penthouse, together with ventilating equipment. The bearing block supporting the west end of this truss was found, after the collapse, on the ground directly below its original position. The end of the truss had swung a distance of about 25 ft. to the north. The load on the pier at the west end of this truss was about 50 per cent greater than the load on the remaining pier. This concrete block was 8 in. thick by 18 in. long by 20 in. deep. The bottom of the block was decidedly rounded and somewhat wedgeshaped. This shaping was not produced by abrasion, because the imprints of the mortar fold and brick were visible. Pockets throughout the block showed that the concrete had not been properly puddled.

The reaction at the west end of the truss supporting the penthouse, considering the dead load only, was about 80,000 lb. The bearing area of the concrete blocks upon which the truss and bearing frame rested was 124 square inches. The minimum stress produced over the maximum area of the block was 550 lb. per square inch. Because of the shape of the bottom of the blocks the actual stress must have been very much more. It is thought that the collapse started at the truss bearing, due to the crushing, wedging, turning action, or combination of these, because of the heavy load due to the penthouse and also because of the springing action of the truss.

The deflection of the truss and the unusual method of supporting the brick wall and penthouse on the top chord of the truss may have contributed to the failure, but if the brick pier had been built up to the bearing in a substantial manner, as was called for on the plans, and if an adequate bearing plate had been provided, the stresses should not have been developed to the point of failure.

Concrete blocks 24 in. thick and covering the entire area of the piers are said to have been called for by the steel company as seats for the roof trusses, but that design was not followed. While this company designed and fabricated the steelwork, the erection was done by the general contractor. The architect prepared no structural drawings and the owners of the building let the contracts as they saw fit, so that there was no one responsible head in control of design and construction. It is reported that in rebuilding the theater steel columns will be built into the brick piers to support the roof trusses. To supplement the preceding quotation we have the following statement from S. G. Dunwiddie, district attorney at Janesville:

> On Sept. 18, 1923, a theater building being built for Saxe Brothers, of Milwaukee, collapsed. The roof, which was of cement construction, fell in, beginning at the southwest corner of the building, upon which the penthouse was located. At the coroner's inquest all parties concerned were thoroughly examined. A number of experts were also called in. Certain things were found which did not comply with the state building code. No particular thing could be found upon which alone the blame could be placed for the collapse of the building. The verdict of the coroner's jury was to the effect that the architect's drawings were insufficient, that the building code of the state was not sufficient, that the inspections by the state and by the city were not sufficient. The jury, however, did not and could not find any person or persons criminally liable.

Roof Trusses—Reporting on the strength of the roof trusses, an engineer who checked the plans after the accident stated that the design provided ample strength. A sketch of one of the heavier end trusses is given in Fig. 1, while Fig. 2 gives the details of one of the intermediate trusses, which had slightly lighter members and fewer rivets. All trusses were 59 ft. 6⅝ in. long over all and about 6½ ft. deep, with top chords spliced at hip and center, and bottom chords at the

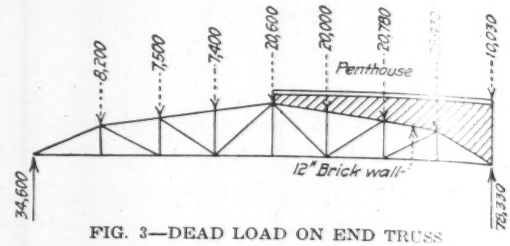


FIG. 3—DEAD LOAD ON END TRUSS

center only. The end of the heel joint was about 12 in. deep, or 7 in. c. to c. of rivets. Fig. 3 (from the report quoted above) shows the dead load on the south truss, which supported the penthouse and which was the first to drop by failure of the west end bearing.

As to the crippling of the trusses, it is stated that after the first or south truss dropped out of place the others were pulled over in succession by the purlins attached to the top chords. As the bottom chords were anchored, the truss in each case was crippled by the lateral pull until either the anchor bolts or the masonry gave way. The truss that was shown in the article noted above is stated to have been the north truss or the last one to be pulled over. In this case the anchor bolts held and pulled out the concrete seats or plugs in which they were embedded. For the reconstruction, it is reported that the trusses will be of the same design but will rest on steel columns built into the brick walls.

Passenger Movements at Railway Stations

CONCLUSIONS as to platform widths and speed of passengers at large railway stations may be summarized as follows from a detailed analysis included in the report presented by the Committee on Yards and Terminals at the recent meeting of the American Railway Engineering Association:

1. Minimum widths for platforms are 13 ft. when used for passengers exclusively, 18 ft. for passengers and trucking, and 11 ft. for trucking exclusively. It is assumed that both the passenger platforms have each a row of columns and that the trucking platform is free from columns. In discharging passengers, the capacity of the platform is 15 passengers per foot of width per minute for through or main-line passengers and 30 for suburban passengers.

2. Discharge of passengers from trains approximates the following rates per car exit: from Pullman cars (after hand baggage has been unloaded), one every 2.6 seconds; from coaches, 3 seconds; from suburban cars, 1.8 or 1.4 seconds for exits 2.4 and 3.4 ft. wide respectively. With high platforms and car doors 2.4 and 4 ft. wide these suburban rates will be 1.1 and 0.8 seconds respectively.

3. Speeds of incoming passengers on platforms under normal conditions and when moving as individuals will average 4.2 and 5.5 ft. per second for through and suburban passengers respectively. When passengers are moving as a crowd the respective rates will be 3.7 and 5.1 ft. per second. The movement of outgoing passengers, particularly where tickets are checked at a train gate, is in a single or double line and covers a relatively longer period than that of inbound passengers who leave all the cars simultaneously and move in a crowd to the exit gates.

4. Ramps of 10 per cent grade have a carrying capacity of 15 through passengers or 30 suburban passengers per foot of width per minute. On stairs the capacity decreases with height, but for stairs 20 ft. high the figures will be 10 and 18 respectively. Escalators have a capacity of 30 passengers per foot of width per minute; they are well adapted for suburban service but there is doubt as to their practicability for through passenger service.

5. Elevators and escalators for heights of less than 25 ft. are not recommended as approaches to individual platforms.

Cement Study Activated by Government Committee

Commerce Department Advisory Committee Announces Joint Study By Cement Association and Bureau of Standards

THE so-called Advisory Committee on Cement and Concrete appointed in January by Secretary Hoover of the Department of Commerce has just issued a statement to the effect that a "broad and scientific investigation of the properties of cement and concrete will be undertaken by the Bureau of Standards in conjunction with the Portland Cement Association." The original announcement of this advisory committee appeared in *Engineering News-Record*, Jan. 31, 1924, p. 211. The current statement is as follows:

The program which is the result of many conferences between the Bureau of Standards and the Portland Cement Association has now received the full endorsement of the Advisory Committee to the Department of Commerce on Cement and Concrete and will be put into effect so soon as the technical forces can be assembled.

The committee was assisted in its conclusions by Assistant Secretary of Commerce J. Walter Drake, and representatives of the Portland Cement Association, the American Concrete Institute, the Bureau of Standards and the Division of Building and Housing, both of the Commerce Department, the Reclamation Service of the Department of the Interior, and the Navy Department.

Besides utilizing the results of its own study of the problem, it is the purpose to secure from all laboratories, research institutions, organizations and individuals such information as they may possess regarding concrete as will permit the committee to recommend to the public the most improved methods for making and using concrete.

The scientific research will include an intensive study of the chemical and physico-chemical properties of portland cements, of the raw materials from which they are manufactured and of the products into which they are converted when used in concrete. The investigation will involve a study of the pure ingredients, the influence of rock impurities and the natural deviations from the maximum composition, the temperature and time effects in manufacture, the reactions occurring in setting, the physical and colloidal behavior and hydration phenomena in setting, and the physico-chemical influence of many extraneous agents possibly affecting the material in service.

At the second meeting of the Advisory Committee there were in attendance all the members of the Committee as follows: John Lyle Harrington, chairman; C. H. Boynton; N. Max Dunning; H. C. Turner; Charles M. Upham.

In addition the following representatives of other organizations were present:

Portland Cement Association—Frederic W. Kelley, president; D. A. Abrams, professor in charge, Structural Materials Research Laboratory; and G. E. Warren, assistant general manager. *American Concrete Institute* — A. E. Lindau, president. *Department of Commerce*—George K. Burgess, director, Bureau of Standards; P. H. Bates, Bureau of Standards; John M. Gries, Division of Building and Housing; and F. P. Cartwright, Division of Building and Housing. *Interior Department*—C. A. Bissell, Reclamation Bureau. *Navy Department*—R. F. Bessey, Bureau of Yards and Docks.

Mr. Kelley presented the outline of the investigation on portland cement through the co-operation of the Bureau of Standards and the Portland Cement Association. In brief the program comprises the following:

Preliminary Program—The following program has been prepared as a preliminary method of attack:

1. Study of available literature on the constitution of cements and related topics.
2. Consideration of related problems which have a bearing on the manufacture and use of cement.
3. Outline of tests.

A. Studies of pure compounds. Preparation of some of the important compounds in cements. These are to be prepared in small amounts, from pure, or relatively pure materials. They are to be subjected to the following:

1. Petrographic examination.
2. Chemical analysis.
3. Behavior on hydration.
4. Other chemical and physical studies.

The objects of this work are: To check results obtained by other investigators and thereby provide a starting point for further studies; and to extend our knowledge of the physical and chemical behavior of these compounds.

B. Studies of impurities, Repetition of (a), except introduction of some of the impurities present in commercial cement (such as MgO, Fe_2O_3, Na_2O, etc.) and study of the effect on the formation of the compounds and on their hydraulic properties.

C. Manufacturing cements in experimental kiln. Similar to (b), except preparation of the compounds in larger quantities in a small rotary kiln so that in addition to the petrographic and chemical studies, specimens may be made for tests of:

1. Soundness.
2. Mortar and concrete strength.
3. Effect of destructive agencies—(alkali, sea water, peat soils, etc.).

D. Studies in existing cement plants. It is intended to take advantage of the possible wide variety of compositions and physical characteristics of raw materials existing in the industry to study the effect of these variations on the properties of the finished cement. The study of the finished cement would follow the lines indicated above for the purer compounds or laboratory prepared cements but would be extended to close observation of the conditions and methods used, as affecting the quality of the cement, existing in the plant, and to the larger and more detailed study of the resulting cements in various services.

E. Hydration of cements, studies of catalysers, etc.

F. Concrete-making value of cements. A study of the behavior of the special cements in concrete, following recent developments in other tests of this kind and applying standard methods to strength, resistance to weather and other destructive agencies.

The work outlined will be carried on jointly by the Portland Cement Association and the Bureau of Standards at the Bureau of Standards. It is contemplated that the Portland Cement Association will supply a staff of six engineers and chemists. This number will be augmented by a similar number from the Bureau. The entire equipment of the Bureau for this type of work will be available.

Purdue to Celebrate Semi-Centennial

PURDUE University at Lafayette, Ind., on May 2 and 3, 1924, will celebrate its semi-centennial anniversary. The first course in civil engineering at the University was offered in the fall of 1874, and, although a few students were enrolled, the course became inactive during the year 1878 and was not revived until 1887, after which date the enrollments in the civil engineering course increased rapidly until 1908, when they fell off sharply again and continued to decline until 1918, when attendance rose sharply and has continued rising.

The first graduate in civil engineering was William J. Eldridge, now of Indianapolis, who graduated in 1877.

In 1887, Alfred E. Phillips was made professor of civil engineering and in 1893 W. K. Hatt became associate professor of civil engineering. Professor Phillips was succeeded by Fred Morley in 1894 and he was in turn succeeded by William D. Pence in 1899. The same year marks the beginning of a rapid development in the laboratory for testing materials at the university. In 1906 Professor Hatt, the associate professor of civil engineering, succeeded Professor Pence.

The School of Civil Engineering at Purdue established a conference of county surveyors, city engineers, and road officials in 1913, and a summer camp of civil engineering in 1914.

Reclamation Advisers Report on Needs of Projects and Policy for Future Irrigation

Original Law Found Ineffective—Some Projects Unable to Pay for Their Irrigation Works—Recommend Repayment According to Productivity of Land—Financial and Agricultural Aid Necessary for Success

UPHOLDING fully the soundness of the work carried out in the West during the past twenty years by the Reclamation Service of the U. S. Department of Interior, and emphasizing also the integrity of the Service, the skill of the engineers, and the correctness of the financial methods, the board of Special Advisers on Reclamation in its report rendered on April 11 gives full recognition to the difficulties in which the irrigation farmers on the government projects have become involved, and recommends in detail what relief should be given on the different projects. It also takes up the question of whether additional reclamation work is advisable, and under what conditions. Its conclusion is that under present conditions of settlement and arid-land farming, the long-time repayment system makes it necessary that the farmers be helped over the difficulties arising from high-interest borrowing, lack of agricultural knowledge with respect to arid-land soils, and absence of economical purchasing and marketing facilities.

Throughout, the findings and recommendations of the board are based on exhaustive study of experience in the development and operation of the twenty-eight reclamation projects throughout the West, coupled with the members' own acquaintance with both federal and private irrigation. The recommendations for future irrigation policy represent a close approach to the views long championed by the new reclamation commissioner, Dr. Elwood Mead, and applied by him during the last six years on the California state land settlements.

The full report, which is very extensive, still awaits printing, but a condensed version of the text has been issued by the board. The principal parts of this version are abstracted in the following.

Twenty-Year Repayment Not Feasible—The requirement of the reclamation law for repayment of the irrigation works by the settlers in twenty years (ten years in the original law) is declared impossible and fallacious, as the repayment power of irrigated land is not the same for all land or all projects but depends on its productivity. The board proposes that the amount of annual repayment by each project shall be 5 per cent of the average gross annual crop production.

Charges on Poor Land to Be Reduced—Under the existing reclamation law, all irrigable land on a given project or unit of a project was rated the same and assessed the same per-acre charge. The board recommends that lands on each project shall be classified with respect to their agricultural value, and that the charges be proportioned to the values so determined. Lands just coming into production and not yet ready to begin repayment are to be exempt until they produce adequately. Lands incapable of supporting a farmer and also repaying the construction costs shall be wholly exempt, and the settler on such land may have the right to exchange it for productive land on the same or another project.

Delinquent Charges to Be Refunded—For present relief from the burden of overdue and unpaid charges, on which a heavy penalty rests, all unpaid or deferred charges both for construction and for operation are to be transferred to the construction cost.

Farmers Must Operate—As a condition of all relief, the farmers must take over the care and operation of the project works (a few individual projects excepted). To give the local operating organizations a better start, an amount equal to one year's operating cost is to be loaned to such organizations. For further assistance to the project farmers, the board recommends that all present and past profits from power plants connected with the projects, the leasing of grazing and farm lands held by the government, and the sale of town sites, be credited on the project construction cost as soon as the water users take over operation.

Financial Aid—As the project farmers now find it difficult to borrow money and must pay high interest rates for loans, the board recommends that they be assisted in improving and equipping their farms through a government credit fund from which they may borrow money on long-term repayment. Such loans, secured by the land, are to be repaid in thirty years in the case of loans for fixed improvements, and in five years in the case of equipment and live-stock loans, with 5 per cent annual interest.

Agricultural and Economic Advisory Service—Agricultural and economic advisers are to be placed on all the projects by the government.

Experience on Present Projects—The general workings of federal reclamation, in spite of some unsatisfactory conditions and some losses to the government, are regarded optimistically:

> There is no doubt about the successful outcome of the Federal experiment in irrigation, if the experience now gained be applied to existing and to coming projects. During the last few years these projects have produced, annually, on about 1,200,000 acres, crops valued at $50,000,000 to $75,000,000, and as the vacant lands are brought under cultivation and the farmed lands are cultivated better, this annual income will increase. Besides, 1,101,700 acres of land are receiving a partial water supply under the terms of the Warren Act from the Federal irrigation projects, and are producing greatly increased crops therefrom. Thousands of happy families are growing up in the open country under influences that have always fashioned men and women of strength. Moreover, these projects have helped in the conquest, for human good, of the more difficult places of our country.

The loss to the government, in part already incurred and in part certain to occur, is due to various causes, whose aggregate result is that it is "not just to require, and in some instances not possible to obtain, the total repayment of costs of investigation, construction, operation and maintenance. Hence the reclamation fund must suffer depletion." The losses represent abandoned projects or items of construction cost already written off, further reductions recommended by the board; and (under the head "Probable Losses") other items depending on the acreage that may be found unprofitable for cultivation. The committee's figures for all the projects are given in the accompanying table.

LOST RECLAMATION INVESTMENT AS ESTIMATED BY ADVISERS

Project	Probable Loss	Definite Loss
Salt River		$382,097
Yuma Auxiliary	None	None
Yuma	$2,700,000	1,361,000
Orland	None	None
Grand Valley	1,000,000	.....
Uncompahgre	1,500,000	47,370
King Hill		1,000,000
Minidoka	None	None
Boise	None	None
Garden City		334,475
Huntley	400,000	100,000
Milk River		3,000,000
Sun River		
Fort Shaw Division	130,000	70,000
Greenfields Division		1,850,000
Lower Yellowstone		1,000,000
North Platte	600,000	None
Newlands		3,500,000
Carlsbad	None	None
Hondo		371,886
Buford-Trenton		294,318
Williston		600,000
Rio Grande	None	None
Umatilla		600,000
Klamath	500,000	250,000
Belle Fourche	750,000	None
Strawberry Valley	None	None
Okanogan	500,000	275,000
Yakima	None	None
Shoshone		
Frannie Division	750,000	2,325,000
Riverton	Under construction	
Secondary	None	1,200,000
Totals	$8,830,000	$18,561,146

Recommendations for Existing Projects

Specific recommendations made for the individual reclamation projects now in operation or under construction, based on full studies of the project histories and on the relations between government and farmers, form an important section of the report. In condensed form they are as follows:

Salt River, Ariz.—Provide for amending contract with Water Users Association in accordance with any future legislation affecting repayment.

Yuma, Ariz.—Credit project with payment for Laguna dam rights made by Imperial Irrigation District. Charge to United States $580,936 as cost of abandoned Arizona main canal. Pay for levee protection by direct government appropriation. Divide the maintenance cost of the levees between California, Arizona, and the United States.

Yuma Auxiliary—The contract conditions fixed by act of Congress in 1917 are impossible of fulfilment. If financial relief cannot be devised, the project should be abandoned.

Orland, Calif.—Water users to operate.

Grand Valley, Colo.—The construction charge to be adjusted in view of large areas of poor soil, which doubled the original charge per acre.

Uncompahgre, Colo.—Spread the project cost, now assessed on 97,410 acres of first-class land, over the total area of 121,942 acres of first and second-class land. Adjust the charge according to productivity, and make the maximum not more than $70 per acre. "The claim of the Uncompahgre Water Users Association that the charge against them should be established at $25 per acre is unjustified by the record."

King Hill, Idaho—Encourage settlement, encourage the breaking up of the larger holdings into smaller units for the benefit of home makers, retain the management in government hands for the present. Hold the present appropriations in suspense until definite plans have been adopted on the basis of study of economic conditions.

Minidoka, Idaho—Add pumping facilities as necessary from time to time. District to operate. Provide further drainage as necessary, and compel the district to furnish drainage to the small acreage of seeped land.

Boise, Idaho—Determine equitable construction charges after a survey of the project lands. Water users to operate. Add drainage cost to construction cost.

Huntley, Mont.—Water users to operate. Construction cost to be not reduced. Adjust water users' claim of overcharge on operation in early years of the project, after investigating. Provide drainage.

Milk River, Mont.—Abandon, unless the water users who have been unwilling to take and pay for water regularly will enter into enforceable contracts for regular supplies. Enter into the proposed contracts with the settlers only if the private land owners agree to absolute sale of excess holdings at prices approved by the government.

Sun River, Mont.—Water users to operate Fort Shaw division. The government to take over excess operation charges prior to 1918. Construct necessary drainage. Repair canal on Greenfield division, provide drainage, and withhold public notice until the division is ready for profitable operation.

Lower Yellowstone, Mont.—Classify in accordance with productivity, and make maximum charge $45 per acre ($60 is excessive because of the low productive value and some unwarranted construction costs).

North Platte, Neb.—Construct Guernsey reservoir. Water users to operate project.

Newlands, Nev.—Construct Spanish Springs reservoir immediately, as otherwise the interests of both the settlers and the government will be seriously jeopardized. Revise present construction charges, the government to take as a loss those items of cost which are found to be non-beneficial to the project. Restudy the 20,000 acres of private lands with prior water rights, for the purpose of either acquiring the lands or obtaining an agreement for their subdivision and sale at a fixed price and bringing them definitely under the project like the other lands.

Carlsbad, N. M.—Investigate additional storage. Failure of project threatened by silting and leaking of the reservoir.

Hondo, N. M.—Abandoned. Appraise and sell.

Rio Grande, N. M.—Make no further appropriations to cover expenditures connected with treaty obligations with Mexico to supply water, as the original appropriation of $1,000,000 is found to be ample. Cancel water-right charges against lands taken for drainage ditches. Complete the drainage system, and continue operation of storage works and the diversion dam. Water users to operate distributing system. Continue investigation for a dam site for future power development.

Williston, N. D.—Discontinue operation. Appraise and sell. The same applies to the Buford-Trenton division.

Umatilla, Ore.—Spread the construction costs of each division over the entire area for which works have been constructed. Determine the type of agriculture suitable for the project. Districts to operate.

Klamath, Calif.—Reduce the charge of $90 per acre on the Tule Lake division. Charge drainage costs to supplementary construction. Deduct from the project cost all costs incurred for lower Klamath Lake land and other areas later eliminated.

Belle Fourche, S. D.—Execute contract already arranged, for adjustment of costs to the value of the irrigation supply.

Strawberry Valley, Utah—Water users to operate.

Okanogan, Wash.—Deduct cost of Salmon Lake and Conconully reservoirs from construction cost. Sell water from these reservoirs on a rental basis. Spread the project cost over the entire area. Deduct cost of power plants unless they are capable of furnishing power as originally planned. Study further possible sources of irrigation water.

Yakima, Wash.—Water users to operate. Adjust repayment charges to productivity on such divisions as elect to accept this plan.

Riverton, Wyo.—Carry on the construction in accordance with the principles developed in the report for new projects.

Shoshone, Wyo.—Abandon Frannie division in whole or in part, on conditions just to the settlers. Water users to operate Garland division.

In its statement of the present situation of the projects, the board says that three projects have failed and that several others may fail if permanent remedial measures are not applied, in which event "the federal reclamation experiment, conceived in a spirit of wise and lofty statesmanship, will become discredited." It then reviews the situation as follows:

The net construction cost of the projects, subject to the repayment as of June 30, 1923, is in round numbers $143,000,000. Of this amount about $101,000,000 are covered by active water right contracts; $39,000,000 unsecured by water contracts.

The water users holding water-right contracts have repaid during the existence of the Reclamation Service 10.9 per cent of the total construction cost subject to the repayment.

On June 30, 1923, of the construction charges then due, 14.2 per cent or $2,537,222.46 remained unpaid, and of the operation and maintenance charges then due, 17.6 per cent or $2,423,649.06 remained unpaid.

We believe it possible, without departing from the intent of the Reclamation Act, and by using the results of the experience of the last twenty-one years, to correct conditions on the projects so that impending disaster may be replaced by lasting success. This will require prompt action; for the present situation has grown to such proportion, throughout two decades, that it can no longer be met by temporary relief measures. The causes of dissatisfaction and failure must be eliminated.

The law required expenditures to be made in the fifteen states mentioned therein in proportion to the sales of public land within those states; and insistent demands were made for immediate selections in each of those states. Studies of water flow and reservoir sites had been made, and some consideration given to soil conditions before the passage of the law, yet sufficient accurate information regarding agricultural and economic feasibility had not been obtained upon which to justify the selection of each of the twenty-four projects which were located within four years after the passage of the law. Some projects were authorized which should never have been undertaken. The simultaneous construction of more than twenty projects, involving the expenditure of nearly $150,000,000, provided no background of experience for the construction of the projects, such as would have been acquired by a more gradual and orderly program of development. This huge construction program soon exhausted the reclamation fund and made necessary a loan of $20,000,000 from Congress to keep the work moving. Thus, construction was done piecemeal and over many years. The delayed construction and the irremediable errors in the original locations increased the project costs and the burden of the water users, who were to repay construction costs from crop incomes.

The construction costs are in almost every instance larger, in some cases several times larger, than the original estimates. This fact, while regrettable, cannot be charged to any one cause. One principal cause was including works not provided for in the original estimates, such as larger dams, also lateral ditches and drainage works. Many of these works are of a monumental character such as high dams and long tunnels, in which unforeseen obstacles were encountered. Whatever the reason may have been, many farmers feel they have been called upon to pay more than they expected to pay and more than they were told they would have to pay; this has become a source of constant attack upon the Reclamation Service and of discontent among water users. Estimates should be made with such care, and construction pushed with sufficient rapidity, to secure reasonable agreement between estimates and costs.

Success can come to future Federal reclamation ventures only if projects are authorized upon a thoroughly scientific consideration of the probable power of the project to enable the farmer to repay construction costs and to win a living from the irrigated lands. Community and political demand to secure projects should be considered only after full knowledge of the feasibility of a proposed project has been secured. Once a project is located, the errors in the choice are felt to the last day. The relief that can now be afforded on existing projects is to classify the lands upon the basis of a scientific survey and place equitable charges upon each class in proportion to its power to produce.

Delayed payments or no payments and the present plight of settlers are not due wholly, however, to increased project costs. The engineering structures of the Federal irrigation projects have been substantially built and maintained; but the farmers' needs have been incompletely met. A fundamental error was made in believing that the construction of irrigation works would of itself create irrigated agriculture. The Reclamation Act was based on that assumption. Attention has been centered almost entirely on engineering features; settlers were accepted without capital or experience. They were not organized to work together, but were left to struggle without sufficient aid or direction to complete what the Government had only begun. It has been demonstrated that the Government can build irrigation structures of the highest quality; but how farmers on the Federal irrigation projects can repay the cost of those structures within reasonable time limits is yet to be demonstrated. The over-emphasis of the engineering side of reclamation by irrigation is one cause of project difficulties.

The project settlers, particularly on the public lands, were unselected as to fitness by experience or financial ability to undertake irrigation farming. Many entered on the venture with little conception of the expenses or physical obstacles they would meet in creating a farm. It was a situation which made the agricultural needs of this heterogeneous body of water users the most important factor in this development. The inexperienced farmer should have been given more and better information and advice; the poor farmer, with honest courage but little or no capital, should have been provided with proper facilities; the farm with a rough, rolling surface should have been leveled; the greedy owner of private lands, ready to trade upon the natural desire of vigorous, hard-working men for independent homes, should and could have been squelched; the good farmer, with small business capacity, should have been given the assistance of co-operative organizations for buying and selling; all should have been supplied with intimate advice, from competent official advisers, on all farm matters; and by every effort the way should have been made easier for the water user, who not only profits by the labor and skill of the engineer, but who also absorbs engineering mistakes and pays engineering bills. Such a singleness of purpose in winning project success by helping the farmer, would have brought greater success to the project, avoided the present danger, and would early have uncovered needed changes in policy or methods.

The Reclamation Service has retained the full management of all but two of the projects. This has not been satisfactory. The project management and the Washington office have become targets for criticism. The water users have come to look upon themselves as wards of the Government, a specially favored class with special claims upon Governmental bounty. The Extension Act provides that the operation and maintenance of the project may be turned over to the water user. This should be done at the earliest possible date. Any benefits that may be devised for the aid of the water users should be contingent upon their willingness to take over the responsibility of operating and managing all but a few of the less settled projects. When this is done, a large proportion of Federal reclamation difficulties will disappear.

It is also a question whether the state in which a project is located should not be required to meet a part of the expense and become an active partner in agricultural development. The partnership of state and nation in good roads and agricultural education has worked well. State participation in selections of projects and in their development would lessen political pressure for projects of doubtful merit and help to lessen the danger of centralized control.

The plan of repayment of construction costs of Federal irrigation projects, as established in the Reclamation Act and subsequent amendments, is inelastic and unscientific. After the first few years, an annual repayment charge of 6 per cent of the acre cost is made for all projects, yet the acre cost and crop producing power vary greatly among projects. Productivity is the only safe and fair basis for fixing annual payments. The expense of changing rough desert land into irrigated fields, and of adding the new implements and improvements needed, involves a large outlay of money which must be won from the products of the farm. The acre income becomes the basis of any scientific method of repaying construction costs. The more fertile the soil is, the higher may be the annual charge; and the more intelligently the farmer cultivates the soil, the sooner will title to his water right pass to him.

Federal water users were tempted, as were other farmers, by the financial riot at the time of high prices during and immediately after the Great War; and they have been caught, with farmers everywhere, by the agricultural depression of the last few years. Meanwhile, many project farmers are still struggling to convert raw, unwilling land into fertile fields, and in this laborious and expensive labor they are worthy of special help.

Numerous minor causes of project distress will be found, but, if (1) the lands of the existing projects are scientifically studied, classified and valued, (2) aid and direction given in agricultural development, (3) the project management assumed by the water users, and (4) a scientific and adequate plan of repayment adopted, all other elements of

project discord and difficulty become of relatively slight importance.

In many of the projects the cost of the works built by the Government, including drainage, is more than $100 an acre. The chief engineer of the bureau has testified before a Congressional committee that he knows of no new project where water can be provided at less than $100 an acre. Experience and investigations show that from $100 to $200 an acre, in addition to the project costs, must be expended by the farmer in improving and equipping the farm. Plans and policies must be formulated which will ensure competent investigations of all the conditions which affect the value of a project both to the Government and the settler. It must fix conditions as to the qualifications of settlers as to capital and experience, which will help create communities able to meet the great demands on them in the way of money for development and ability to use soil, water, and climate, as success in irrigation requires. Without these things, Government irrigation in the future will provide temptations rather than opportunities.

The old pioneer settlement with its primitive farming is impossible under present conditions. Capital, technical knowledge, credit, and technical advice are all needed to make farming profitable under these costly projects. The farmers' needs must be kept in mind in re-writing this act if Federal reclamation is to succeed.

A Policy for Future Reclamation

As much attention was given by the board to developing the conditions which should be incorporated in future reclamation, if any, as to the study of troubles on the present projects. The essentials of a complete policy are outlined by the board in the form of a number of recommendations which the official abstract summarizes as follows:

That no reclamation project shall be hereafter authorized until all privately-owned land in excess of a single homestead unit for each owner shall have been purchased by the United States or by contract placed under the control of the Reclamation Bureau for sub-division and sale to settlers at an approved price.

That in the settling and disposition of farms upon projects, the Government should examine into the qualifications of the prospective settlers, who must have industry, experience, character, and capital. Only those who have reasonable prospects of succeeding should be permitted to settle on projects.

That the expense of leveling project lands and building suitable distribution systems for efficient and economical irrigation shall be made a part of the construction costs to be assessed on new projects as are other construction costs.

That no new projects or extension of existing projects shall be authorized until full information has been secured concerning water supply, engineering features, soil, climate, transportation, markets, land prices, probable acre cost of development, and other factors upon which the success of a project must depend. That all such information shall be secured through designated representatives of the Departments of the Interior, Agriculture, and Commerce, who shall, after careful investigation, make to the Secretary of the Interior a report upon the feasibility of the project or the extension of an existing project, having in mind primarily the creation of opportunities for actual settlement and farm homes and the repaying of the total investment made by the Government.

Provisional Recommendation of Four New Projects

Of the numerous important projects which have recently been proposed to the Reclamation Service and have been under study, the board recommends that the construction of four be authorized, but under the condition that their profitable character be clearly demonstrated in advance and that the principles above outlined for the conduct of new projects be followed. The four projects are the Owyhee and Vale, Ore.; Salt Lake Basin, Utah; Kittitas, Wash.

As to these new proposed projects, the committee does not have sufficient information upon which to make specific recommendations. Attention is called to the fact that the estimated costs of construction are nearly all in excess of $120 per acre. The committee is of the opinion that projects requiring such acre costs as above suggested should be constructed only after it is clearly shown that the lands, when irrigated, can produce annual crop values sufficient to enable the settlers to repay costs from production, and within a reasonable time.

The Board of Special Advisers was appointed by Secretary Work some weeks after he discharged Arthur P. Davis, director of the Reclamation Service for more than ten years, and replaced him by David W. Davis, ex-governor of Idaho, at the same time changing the title of the Service to Bureau of Reclamation and taking the operation of the projects away from the engineering organization. The board was originally known as the Fact Finding Commission, but later was given its present name of Board of Special Advisers on Reclamation. It is composed of James R. Garfield, Secretary of the Interior under Roosevelt, at a time when some of the early problems of work under the Reclamation Act of 1902 were being worked out; Dr. John A. Widtsoe, former president of the University of Utah, an authority on irrigation and agricultural conditions, who has written several books on the subject; Dr. Elwood Mead, former state engineer of Wyoming, chief of irrigation and drainage investigations of the U. S. Department of Agriculture, professor of irrigation institutions and of rural institutions at the University of California, head of the Water Resources Department of the State of Victoria, Australia, and later consultant to New South Wales on land and irrigation questions, who has recently been appointed commissioner of reclamation to carry out the recommendations and policies of the Board of Special Advisers; Thomas E. Campbell, former Governor of Arizona; Oscar E. Bradfute, president of the American Bureau Federation; and Clyde C. Dawson, attorney, Denver, representing the Chamber of Commerce of the United States. Julius H. Barnes, president of the Chamber of Commerce, was originally appointed, but Mr. Dawson took his place. The board organized late last fall by electing Governor Campbell as chairman and Dr. Widtsoe as secretary, and has been continuously in session holding hearings, collecting data and the like since then. Its studies included a hearing at Salt Lake City where representatives of water users were heard, and special visits to a number of the projects subject to particularly difficult conditions.

Concrete Piles Unaffected by Sea Water

Reclaimed reinforced-concrete sheetpiles were used by the Gulf, Colorado & Santa Fé Ry. for the foundations of the canopies over the new platforms at its station at Galveston, Tex. The sheetpiling had been removed from the Galveston causeway more than a year ago when a portion of the fill was replaced by extending the viaduct. Although the piles had been exposed to sea water since 1910, they were found to be in first-class condition. They were made of 1:2:4 concrete and were cured two months before being driven. Some of the reinforcing was exposed during the removal of the piling and it was found to be unaffected by the action of sea water. The piles were so sound that none of them were broken in the redriving.

Progress on North Outfall Sewer for City of Los Angeles

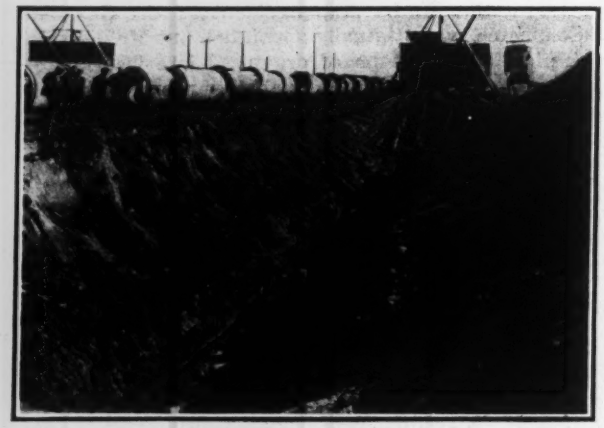
Traveler for Placing Concrete Pipe Sections Spans Trench—Work Done Under Several Contracts Largest Pipe 102 In. in Diameter

By W. T. Knowlton
Engineer of Sewers, Los Angeles, Calif.

SINCE LAST summer plans and specifications for all of the 14 sections of the North Outfall Sewer for the City of Los Angeles (described in *Engineering News-Record*, June 7, 1923, p. 1000) have been completed and the Board of Public Works has awarded contracts. The work on the upper end of the line, with 8½-ft. concrete pipe in 6-ft. lengths, is shown by the accompanying illustrations.

On final consideration it was decided to have the lower sections of this outfall sewer built along the north and west slopes of the hill on the south side of Ballona Creek, rather than in tunnel as originally planned. This change made an appreciable difference in the estimated cost and will lessen the time for the completion of the entire sewer. Bids for that part of the sewer along the coast from Hyperion to Playa del Rey were opened by the Board of Public Works on Dec. 17. The contract for this part (known as Sec. 4) was awarded to the Ross Construction Co. Upon completion of this section, arrangements can be made to pump sewage from the cities of Venice and Santa Monica into this sewer, using a pumping plant which can later be placed at the upper end of this section.

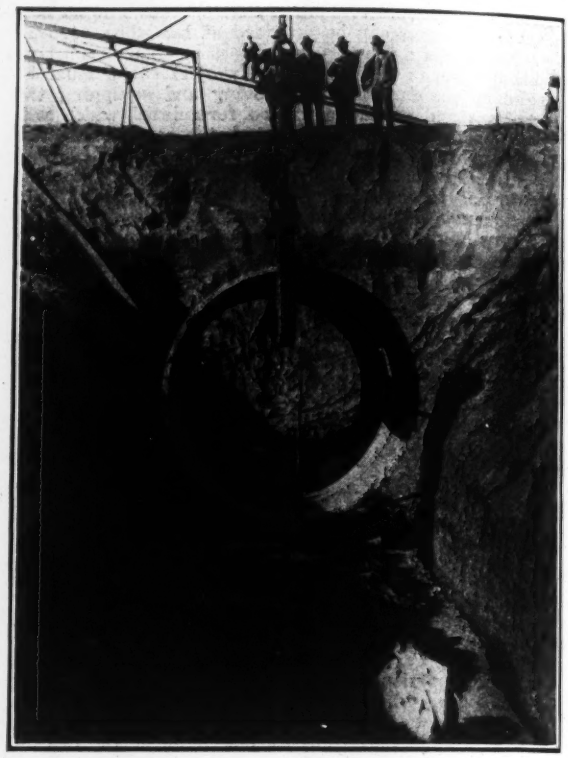
At the Hyperion end of this sewer, the removal of sand hills to provide proper location for the treatment plant has been completed for the south part of the screening plant, which is to receive the sewage from the existing outfall sewer and practically all of this



EXCAVATION OF TRENCH WITH 2-YD. DRAGLINE
In the foreground are shown the concrete blocks on which the pipe is to be laid. View taken Dec. 1, 1923.

work was done before the first of the year. Concrete pipe 84 in. in diameter for Sec. 1, the ocean end of the sewer, is now being made at Hyperion. The contract for placing this pipe was let to the Merritt-Chapman, Scott Co. of New York.

In order to have the south part of the Hyperion treatment plant completed at the earliest possible date, the city has built the foundations on force account for the eight Dorrco screens to be installed there, each of



LOWERING THE FIRST SECTION
The pipe is lined with vitrified clay tile and is placed on concrete blocks previously set to grade in the trench.

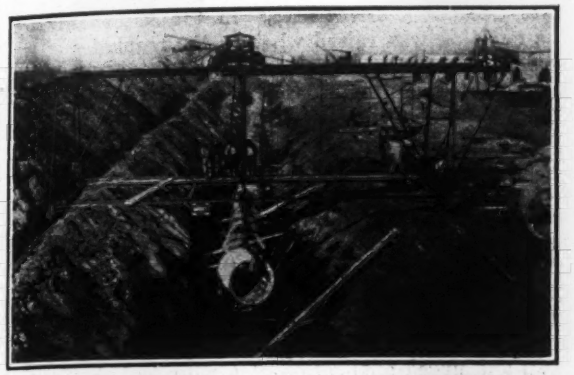
which has a capacity of 10 m.g.d. Upon the completion of this south screening plant, all sewage discharged into the ocean will first be screened, thereby removing the solid matter that now goes into the ocean and some of which is deposited along the beaches. The effluent from this screening plant will for a short time only discharge into the ocean at a distance of 2,000 ft. from shore where the depth is about 20 ft. When Sec. 1 has been completed the present ocean outfall will be abandoned and the screened sewage discharged into the ocean at a distance of about 5,700 ft. from shore where the depth is about 54 feet.

After receiving competitive bids for the construction of this sewer, based on three types of construction, it was decided to use precast reinforced-concrete pipe for Secs. 10 to 14 inclusive, which comprise that portion of the work between Ballona Creek and Arlington Ave. Contracts for the pipe for these five sections were awarded to the Western Reinforced-Concrete Pipe Co. of Los Angeles. Early this year the larger part of this pipe had been made along the line of trench, where it was left to cure. Prior to the first of the year the contract for placing pipe in Secs. 11 to 14 was awarded to the Thomas Haverty Co. of Los Angeles, and that for Sec. 10 was awarded to Smith Bros. and W. E. Callahan, Inc. Construction on Secs. 10, 11, and 13 was under way early in January.

Plans for the lower portions of the sewer have been

drawn so as to have a monolithic structure, semi-elliptical cross-section, 10½ ft. high and about 12 ft. wide.

In addition to the work being done by the city under force account at the Hyperion plant, the city is building secs. 5 and 7. Sec 5 is a tunnel about 2,900 ft. long



TRAVELER LOWERING SECTION OF CONCRETE PIPE

and Sec. 7 includes a tunnel and a siphon with a combined length of about 3,000 ft.

The construction of all work on the outfall sewer is under the direct supervision of H. A. Van Norman, who was appointed by the Board of Public Works to take charge of this work.

Opportunities for Young Engineers in the Government Service

Washington Correspondence

WHILE no unusual number of vacancies exists, or is in prospect in the engineering services of the federal government, the U. S. Civil Service Commission is exerting strong efforts to interest a large number of young professional men in the examinations for junior engineers, which will be held throughout the country May 9. It is hoped by the commission to secure a sufficient list of high-class eligibles at this examination to take care of the expanding needs of the federal government for technical men and make up the losses suffered by turnover in personnel during the next year.

In order to call the examination to the attention of those qualified to take it, press bulletins and other announcements are being sent to newspapers and to universities and colleges and radio addresses on the opportunities offered by the government to young engineers are being delivered by officials of the Civil Service Commission. The examination May 9 embraces most of the specialties in the field of engineering. In some of these no vacancy exists in the government service, but an eligible list is necessary to care for future needs. In others there are vacancies existing to which appointments may be made as soon as eligibles are selected.

The optional subjects include the following divisions of engineers: Aeronautical, agricultural, ceramic, chemical, civil (general), electrical, electro-chemical, fisheries, hydraulic, materials, highway, industrial, irrigation and drainage, mechanical, mining, petroleum, radio and structural.

In the way of opportunities for early appointment, the Civil Service Commission states that the water resources branch of the U. S. Geological Survey in the next year is expected to appoint 25 to 50 junior engineers in irrigation and drainage engineering and in hydraulic engineering. The Bureau of Public Roads is expected to appoint about twenty junior highway engineers. The roads bureau last year made twenty-two such appointments and exhausted the list of eligibles for its work. The Bureau of Standards is expected to have several vacancies for junior radio engineers and materials engineers. The Bureau of Public Roads has developed a special demand for highway bridge engineers.

According to H. E. Morgan, director of recruiting; Luther C. Dodd, assistant chief of the examining division in charge of technical examinations; and Dr. A. S. Ernest, technical examiner, of the Civil Service Commission, the commission is especially desirous this year of building up a strong list of eligibles for the engineering services of the federal government.

According to Mr. Morgan who recently broadcasted from the Arlington radio station a talk on the need of the government for young engineers the federal government employs approximately 2,000 civil engineers alone, and all told about 8,000 engineers of various kinds. Each year hundreds of junior engineers are appointed both to recruit new projects and to take the places of those who are promoted to higher positions and those who leave the government service after acquiring the experience and prestige to accept employment in private industry.

Under the new classification act, the entrance salary for junior engineer positions within the District of Columbia will be $1,860 a year after June 30 with advancement in pay without change in assignment to $2,400 a year. The highest salary paid to any engineer under the classification is $7,500 a year unless a higher salary is especially authorized by Congress. Outside of the District of Columbia the entrance salaries range from $1,200 to $1,800 a year with an addition of a bonus $20 a month.

Large Penstocks for Power Plant in India

Commenting on a large contract for steel pipe recently let in London for use in connection with the Tata Power Co.'s hydro-electric scheme in India, *The Engineer*, London, says the scheme is known as the Mila-Mula, or Bhira, and is the third and greatest of the Tata enterprises for conserving and harnessing the storm water of the Western Ghats, and conveying it by a pipe line to turbines and generators for the production of electric power to be transmitted at 110,000 volts to Bombay, some 80 miles distant. According to this account, the order is the largest ever placed in Great Britain, if not in the world, and follows upon a similar contract for 27 miles of 54-in. lap-welded steel pipe for the Thirlmere water scheme, now approaching completion. The pipe line at its head will consist of three lines of 84-in. internal diameter pipe of riveted construction, bifurcating into six lines of riveted pipe, reducing from 58½ in. to 54½ in. in diameter followed by six lines of 54-in. lap-welded pipe gradually reducing to 51-in. diameter, and finally branching into twelve lines of 36-in. pipe supplying water to twelve impulse wheels. The approximate length of the pipe line, from tunnel mouth to power house, is 5,850 ft., and the maximum head of water is 1,672 ft., corresponding to a pressure of 725 lb. per square inch. The approximate total weight of this pipe and special fixtures is nearly 9,000 tons.

Building Officials Meet At Louisville

Discuss Architect's Relation To Building, Work of Inspectors, and Non-Occupancy Structures in Cities

THE TENTH annual meeting of Building Officials' Conference, held at Louisville, April 8-10, marked a great advance over earlier meetings, with a total attendance of 95.

The chief discussion centered around the addresses of Brinton B. Davis, architect, of Louisville, on "The Relationship Between the Architect and the Building Department," and Frank P. Cartwright, technical secretary of the Building Code Committee of the U. S. Department of Commerce, on "The Building Inspector As He Appears to the Public." Both indicated that the functions of the building inspector and the place occupied by building regulation in the general scheme of municipal administration are generally misunderstood. Among the points made are: that many building codes are out of date; that appropriations for the administration of the building laws are inadequate; that building permits are issued to persons of questionable competence and responsibility to carry out safe construction; that the public generally has little confidence in the administrative official regarding him frequently as nothing more than a job holder; that the enforcement of building code requirements is often arbitrary, because the official has not adequate discretion; and that building officials are often unjustly held responsible for failure to anticipate unsafe construction and to apprehend violations of the law. The need for greater restrictions in the issuance of permits to persons competent to design and willing to assume responsibility for safe construction was again emphasized, as it had been at previous meetings.

Appointment of a committee to consider the best means of securing safe and lawful construction was authorized, with the understanding that such committee would co-operate with architects, engineers and builders who may be working along the same lines.

Wind pressure constituted the chief topic of discussion in the consideration of the tentative report issued by the Building Code Committee of the U. S. Department of Commerce, on "Minimum Live-Load Requirements for Use in Design of Buildings." The general sentiment seemed to be that the present requirements are too severe, and that the usual pressure of 30 lb. per square foot is unnecessarily high, though data on the subject are meager. Among other things, it was suggested that minimum live-loads might be less when fireproof construction is used than would be permitted in buildings of ordinary or frame construction.

An entire session was given over to the presentation, by L. H. Miller, of Cleveland, of the standard specification of the American Institute of Steel Construction for the design, fabrication and erection of structural steel for buildings. Among other things the reasons for using in these new specifications a column formula which is deemed theoretically correct, as against an empirical straight-line formula, were outlined, but they were not received as conclusive.

In a paper by J. C. Pearson, of the U. S. Bureau of Standards, on "Investigations on Stucco," it was pointed out that the chief factors in the successful use of that construction are thorough workmanship, the use of an absorptive base for stucco, and proper water content.

Two closely related papers were read by George R. Hauser, building commissioner of Cincinnati, on "The Scope and Limitations of a Building Code," and Fred W. Lumis, building commissioner of Springfield, Mass., on "Non-Occupancy Structures," in the latter of which the question was raised whether the regulation of gas holders, storage tanks, coal bins and other such structures should be provided for in building codes. There was a general feeling that this question should be answered affirmatively. The discussion also indicated a general tendency to avoid making specifications of building codes by incorporating details, and to provide greater flexibility with a view to encouraging development in building construction.

A new thought was expressed in the paper on "Limitations of Floor Areas in Buildings" by R. G. Kimbell, architectural engineer. The speaker deprecated the present arbitrary limits that are found in building laws and urged application of a more logical principle. He developed a formula that took into account the relation of the depth to the width of the building as well as the total floor area.

In the paper on "Efficiency in a Building Department" by H. E. Plummer, inspector of buildings, Portland, Oregon, the use of more modern methods in organizing both office and field forces for the administration of building law was advocated for the purpose of giving greater service to the public and making dealings with that office easier and more convenient. Among the topics discussed was the establishment of branch offices, the larger use of mails for the sending of permits, embodiment of specifications in the permit, the reports by employes of work done, the use of automobiles in inspection work, the employment of more competent help for the examination of plans, the encouragement to better work by giving recognition to satisfactory service as well as accountability to unsatisfactory work.

A scholarly paper on "Legal Aspects" was presented by Frank Burton, commissioner of buildings of Detroit, Michigan, reviewing fully the basis in law for the exercise of police powers as related to building work.

The committee work of the organization has grown in extent and usefulness. Besides committees considering suitable building code requirements for different materials, the organization has representatives on a number of the sectional committees of the American Engineering Standards Committee, and contact men with activities of the federal government.

The president and secretary elected for the coming year are Frank Burton, commissioner of buildings, Detroit and J. F. Downey, building commissioner, Cambridge, Mass.

Railway Electrification in South Africa

Electrification of the Natal Main Line, South Africa's heaviest traffic line, between Moritzburg and Glencoe, a distance of 170 miles, is well under way. A large part of the overhead conductor system has been erected, the first electric locomotives will be delivered in the near future, and the power station at Colenso will be ready by midsummer. It will contain five turbo-alternators, giving a continuous output, each, of 12,000 kw. at 6,600 volts, three phase, and a 2-min. peak load output of 20,000 kw.

Engineering Literature

A MONTHLY REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Text-Books on Hydraulics

REVIEWED BY WESTON E. FULLER

Consulting Civil Engineer, Professor of Civil Engineering, Swarthmore College, Swarthmore, Pa.

ELEMENTARY HYDRAULICS—By F. W. Medaugh, Instructor in Civil Engineering, the Johns Hopkins University. New York: D. Van Nostrand Co. Cloth; 6 x 8 in.; pp. 144; one folding diagram plate and 71 text illustrations, mostly line cuts. $2.

HYDRAULICS: A Textbook for Students and Engineers—By Ernest H. Sprague, A. M. Inst. C. E., Lecturer on Hydraulics at University College, London, etc. Second Revised and Enlarged Edition. With Numerous Worked Examples. [The Broadway Series of Engineering Handbooks.] London: Scott, Greenwood & Co. Cloth; 5 x 8 in.; pp. 274; 89 figures in text.

Professor Medaugh's book is designed as a text on elementary hydraulics. It contains many excellent illustrations of hydraulic problems which should serve to make the subject clearer to the student, and should be useful to the instructor, if used jointly with a more complete treatise. Taken alone it is lacking in treatment of the fundamental theory. There is a tendency to start with the practical formulas which are commonly used without adequate explanation as to the relation of these formulas to the theory. These formulas have been selected with care and the experimental data upon which they are based are well presented. While it is recognized that this type of formula must be depended upon to a large extent in solving practical hydraulic problems, yet the underlying theory must be clearly understood by the student if he is to use the formulas intelligently.

The book contains many excellent problems which well illustrate the more important matters. It deals to a large extent with the flow of water in pipes and conduits, over weirs, and through orifices. The portion devoted to hydrodynamics consists of only three pages and that devoted to the fundamental theory of hydraulics is very limited.

The new edition of Prof. Sprague's book is an unusually well balanced text on hydraulics. The matter included is all essential and the author has used rare judgment in presenting the important while eliminating the less important and the details which only serve to confuse the student. The book covers a surprisingly large field in a comparatively small space. The selection of the formulas and the data presented are excellent although some of the generally accepted American work is not touched upon. The illustrations are well made, of simple form and easily read and understood. There are many examples given which have been carefully selected, thus adding greatly to the value as a text-book. A sufficient number of these problems have been worked out to illustrate the text, the remainder being left to the student for solution. Answers are given to all.

The book opens with a discussion of hydrostatics which is clear and concise. The remainder of the book is devoted about equally to discussions of flow of water through weirs, orifices, pipe and conduits and to the principles of motors, pumps and hydraulic machinery. The book is well written and the arrangement of the subject matter is good. It should prove an excellent text-book, and contains much of value to the engineer in practice.

Deluded and Deluders in Science

FOIBLES AND FALLACIES OF SCIENCE: An Account of Celebrated Scientific Vagaries—By Daniel W. Hering, C.E., Ph.D., LL.D., Professor Emeritus of Physics and formerly Dean of the Faculty of the Graduate School in New York University. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. 294; line cuts and halftones. $2.50 net.

The subtitle of Dr. Hering's interesting and instructive book, Celebrated Scientific Vagaries, well indicates the author's method of dealing with his main subject. He has adopted the narrative form of presenting certain classes of Foibles and Fallacies of Science. In this his book differs materially from the voluminous Popular Fallacies Explained and Corrected by A. S. Ackerman noted in these columns Feb. 21, p. 332, in which 1,350 fallacies, except for grouping, are separately treated. The comparison is not intended to discredit the earlier-noticed book which has advantages of its own, but merely to make clearer the nature of the one before us, which is more restricted in scope and more organized and scientific in method—without going deeply into technicalities.

After an appropriate introduction Dr. Hering takes up a dozen main classes of fallacies and foibles under these heads: Astrology, Almanacs, Transmutation of Metals, Perpetual Motion, Overturning of Scientific Hypotheses (including Newton's theory of gravitation), Divination, Geographic Mania, Hoaxes, Prophecies, Charlatanism, Radiation and Other Ancient Chimeras —human flying, universal solvent, elixir vitæ, etc.

The book is thoroughly readable. Its interest is heightened by well selected portraits and other illustrations. It is well designed to encourage true and discourage pseudo-science. It is tolerant of the deluded without sparing those who would knowingly delude. It recognizes the difficulties often experienced in drawing the line between these two classes.

Housing Progress in Europe

HOUSING PROGRESS IN WESTERN EUROPE—By Edith Elmer Wood, M.A., Ph.D., Author of The Housing of the Unskilled Wage Earner. New York: E. P. Dutton & Co. Cloth; 6x9 in.; pp. 218; halftones and line cuts. $3.

After an extensive survey of current European housing activities and plans for the future and wide knowledge of conditions and prospects in the United States, Mrs. Wood concludes that in both public opinion and actual accomplishment the countries of Western Europe are leading America in meeting the housing problem, made so much more serious by the late war. Great Britain, Belgium, France, Italy and Holland are the countries surveyed. Private initiative and state action are separately treated in the cases of Great Britain and France. Garden cities and suburbs are given attention. State legislation on housing is summarized in considerable detail. There is a sufficient bibliography.

A Great Naval Architect

THE LIFE OF SIR WILLIAM WHITE, K.C.B., F.R.S., LL.D., D.Sc. By Frederic Manning. With an introduction by the Rt. Hon. Lord George Hamilton, G.C.S.I., LL.D., D.C.L. New York: E. P. Dutton & Co. Cloth; 6 x 9 in.; pp. 502; frontispiece portrait and 12 diagrams. $8.

It would be impossible to write the life of Sir William White without writing into it a considerable part of the history of naval architecture in Great Britain from the early eighties until the late war, a period which saw the British Navy develop from the heterogeneous collection of warships that it was when that country was on the verge of war with Russia in 1885 until it became the greatest fighting unit afloat. Frederic Manning has realized this and has seized the opportunity thus afforded to present almost a history of the development of naval architecture during the years of Sir William White's public life. There are chapters on the Naval Defense Act, the dock yard reforms, the various types of battleships, and much about the administration of the admiralty. As White's designs were used in many ships built for foreign navies as well as in modified form by foreign shipbuilders, a considerable amount of space has been devoted to his observations and correspondence on this subject.

Sir William White's great contribution to British history lies not only in the fact that he was a great naval architect, but also in his ability as an organizer and a public speaker. By his ability as an organizer he effected the dock yard reforms which were largely responsible for the economy and speed that made it possible for the British government to keep the navy abreast of developments in naval architecture, and by his power of speech was able to impress upon Parliament the needs of the navy and was also able to gain and keep the confidence of the people.

The latter years of Sir William's life were darkened by the failure of the design for the Royal yacht, and, although he remained in the admiralty for some years after the incident, the censure to which he was subjected resulted in his retirement from public life at a time when many of the changes which he had instituted would have been benefited by his continuance in a position of responsibility. The details of these events, as well as of many of the earlier ones, have been brought out by Mr. Manning by quoting freely from Sir William White's letters and reports.

For the Intelligent Groups

THE COMMUNICABLE DISEASES: How They Spread and How They May Be Controlled—By Allan J. McLaughlin, M.D., Surgeon, U. S. Public Health Service. Formerly City Health Officer, Manila, P. I., Acting Director of Health, Philippine Islands, Chief Sanitary Expert, International Joint Commission; State Commissioner of Health of Massachusetts and President of the American Public Health Association (1922). New York and London: Harper & Brothers. Cloth; 6x9 in.; pp. 269. $3.

In recognition of the fact that education is essential to the use of the great body of practical knowledge which, if only used, would speedily banish many communicable diseases, and that there "is a wealth of technical litearture . . . on the various specialties of public health work," Doctor McLaughlin has made a successful attempt to produce a book "for the use and education of the great intelligent group which comes between the class served by the text books and the class which can digest only the simple leaflet. This class includes "doctors, lawyers, teachers, social workers, club women, business men, business women and others." people with intelligence to read and digest the technical books "who will not take the time to do it."

In fifty introductory pages the author outlines the causes of communicable disease, the development of bacteriology and of epidemiology and vital statistics, the role of carriers, quarantine, isolation and the present-day conception of disinfection, "our inadequate control of communicable diseases and how it may be made adequate." He then takes up the various communicable diseases classified as to the means by which they are spread: Discharges of the mouth and nose, intestinal discharges, insects and animals. Failure to use the more recent vital statistics, especially under typhoid, where 1920 figures are the latest employed, is a minor fault of the book, which deserves wide circulation and use.

Industrial Plants

MANAGEMENT ENGINEERING: The Design and Organization of Industrial Plants—By P. F. Walker, M.M.E., Professor of Industrial Engineering and Dean of the School of Engineering at the University of Kansas. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x10 in.; pp. 359; 32 diagrams and halftones. $3.50.

Factory design and layout, says the author in his Preface, is "demanding more of the time and energy of the engineer today than is the design of the steam engine. Economy in production, on which the industrial future of this country will depend, is something that is directly associated with the layout of industrial plants and the effective control of material as it flows from the stock bins to the shipping platform, and of labor in its manipulative work." The book is designed for classroom use. It deals first with plants and their design; then with organization and administration. An appendix takes up contracts of various sorts and another gives forms used in company organization. There is a bibliography.

Rainfall at 5,126 British Stations

BRITISH RAINFALL, 1922: Report on the Distribution of Rain in Space and Time over the British Isles During the Year 1922 as Recorded by More Than 5,000 Observers in Great Britain and Ireland. London: H. M. Stationery Office. Issued by authority of the Meteorological Committee, Meteorological Office—Air Ministry. [62d annual volume of British Rainfall Organization.] Cloth; 6x9 in.; maps, illustrations, and tables. 15s. net, in England.

The number of rainfall stations in the British Isles has increased from 471 in 1861, the date of the beginning of the voluntary Rainfall Organization lately taken over by the government, to 5,126 in 1922, the latest year covered by this interesting report. At the outbreak of the war in 1914, the number of observing stations was at its peak—5,453. At that date there were 4.5 stations per 100 sq.mi. against 4.2 in both 1921 and 1922.

Before coming to the main detailed figures, evaporation and percolation for a few stations are given, and there are various summaries dealing with such matters as days with rain, droughts and dry spells, rain spells and wet spells, duration of rainfall, heavy rains in short periods, heavy falls on rainfall days, monthly rainfall, seasonal rainfall, and some figures comparing the total rainfall of 1922 with the average for the period 1881 to 1915.

The main part of the volume consists of a general table of total rainfall in 1922 for the 5,126 stations given. The plan of this table is to give the names of the observers, the diameter of the rain gage in each case with

its height above (1) ground level and (2) sea level; the depth of rain in both millimeters and inches; the days with rainfall totaling (1) 0.01 and (2) 0.04 of precipitation.

In conclusion there are two papers by John Glasspoole on fluctuations in monthly rainfall and on comparisons of fluctuations in annual rainfall over the British Isles.

The publication is a creditable one—as its predecessors have been for decades past—and should be of much general interest outside of the British Isles as it certainly is of great practical value within that area.

The Union Pacific Railroad

HISTORY OF THE UNION PACIFIC: A Financial and Economic Survey—By Nelson Trottman of the Wisconsin Bar. New York: The Ronald Press Co. Cloth; 6 x 9 in.; pp. 412; 3 halftone plates and 7 maps. $5.

Although Mr. Trottman's book is appropriately subtitled "A Financial and Economic Survey," engineers generally will find in it much to interest them. Especially will it appeal to those who think of their work in terms of community service rather than as a series of scientific and technical exercises. For after all, engineering is but a means to an end. That end always is a community service of some sort, to be achieved only through the social and economic machinery that has been developed by the community to administer its diverse and complicated activities. An understanding of this machinery, therefore, and a knowledge of how it operates in specific cases, is a valuable part of the equipment of any engineer who is ambitious to apply his technical attainments most effectively. The more he knows about the agencies through which his conceptions must be realized, the more intelligently can he direct his efforts toward a maximum of accomplishment with a minimum of lost motion, wasteful friction and misdirected energy.

This history is a study of one such specific case. It deals with the provision of transcontinental transportation—an engineering problem—as influenced by the financial, political and economic ideas and practices of the period during which it has been in process. Says Mr. Trottman:

> Many important lessons are to be learned from the successive stages of Union Pacific history: the launching of the road with fervid but hasty enthusiasm and in a peculiar degree with national backing; the profligacy and chicanery of old-time railroad management, by which resources and good will were alike thrown away; the collapse and receivership; the speedy revival and expansion in the hands of competent management; the final stage of close governmental supervision of private initiative culminating in the Railroad Administration and the Esch-Cummins Law of 1920. . . . The story of the Union Pacific shows the vitality of a rightly located railroad, and its power, under competent management, of working free from the handicaps of financial exploitation, and becoming a source of profit to its stockholders and of service to the entire community.

Among the chapters of particular interest to engineer-readers are those that deal with the construction contracts and the work of construction, and with the rehabilitation after the receivership of 1893-1897. The last is perhaps the most instructive, as illustrating the extraordinary achievements possible to skillful engineering when supplemented by sound economic leadership that correctly senses the end and astute financial judgment that provides most thriftily the necessary material resources. Without such supplements it is not difficult to imagine that identical engineering skill wasted in futile endeavor and utterly barren of service to the community. It was this all-round co-ordination of means to accomplish a sound purpose—and not any one of them alone—that created a new Union Pacific out of "two rusty streaks of iron on an old roadbed" and raised the reputation of Edward H. Harriman from that of a shrewd Wall Street trader to rank with those of the ablest railroad managers of his time.

PUBLICATIONS RECEIVED

THOSE CURIOUS TO SEE what the people of the United States, or that part of them engaged in gainful pursuits, were doing in 1920 may satisfy themselves as fully as they desire by delving into the 1,309 pp. comprising Vol. IV., Population; Occupations, just published by the Bureau of the Census ($2.25 from Superintendent of Documents, Washington, D. C.). Statistics are given showing "the distribution of the gainful workers by sex, color or race, nativity, parentage, age, and marital condition" for the United States and "for its geographic divisions and states" by cities of 25,000 population or more; and for Alaska, Hawaii and Porto Rico. In some of the grand summaries comparative figures back to 1880 are given. "Technical engineers" numbered 136,121 in 1920 against 88,755 in 1910. The 1920 total is divided thus: Civil engineers and surveyors, 64,660; mechanical (includes "technical engineers not otherwise classified"), 37,689; electrical, 27,077; mining, 6,695. Not included in these figures there were, in 1920, 15,410 designers, 52,865 draftsmen and 2,376 inventors.

DATA ON WATER TREATMENT PLANTS IN ILLINOIS are given on a broadside, 36x42-in. chart issued by the State Department of Health. Statistics are given on 87 supplies relating to population, source of supply, consumption, filter construction, pre-treatment, filter operation, sterilization, clear water storage, chemical and bacterial analysis, and analytical control.

THE MUNICIPAL ENTERPRISES OF GLASGOW, SCOTLAND, are the subject of a handsomely illustrated "lecture," printed in pamphlet form, by Sir John Lindsay, Town Clerk of Glasgow. Among the many municipal services described are those of water supply, sewerage, the cleansing or street cleaning and scavenging departments, gas works and housing schemes. This, however, is only a small part of the activities outlined in the lecture.

STUDIES AT THE SEWAGE SUBSTATION conducted jointly by the New Jersey Agricultural Experiment Station at New Brunswick, N. J., and the State Department of Health for the year ended June 30, 1922, are reviewed in the report by Dr. Ralph O. Smith. One of the longer papers in the report is on the Animal Population of a Sewage Sprinkling Filter, by W. S. Crozier and E. S. Harris.

THE LIGNITE UTILIZATION BOARD OF CANADA has issued a 261-pp. report, with many folding plates and other illustrations, covering its operations from Oct. 1, 1918, to Jan. 1, 1924. ("$1.50 after free circulation is exhausted.")

RECARBONIZATION OF SOFTENED WATER AT DEFIANCE, OHIO, by Nicholas S. Hill, Jr. (112 E. 19th St., New York City), has been reprinted as a separate from the March *Journal* of the American Water Works Association.

A NEW PUBLICATION devoted to the subject of water resources and utilization in Italy has just made its appearance, under the title *Annali delle Utilizzazioni delle Acque*. It appears under the direction of Carlo Bonomi, editor of the *Annali del Consiglio Superiore delle Acque*, published during five years until in the early part of 1923, when the Water Commission was abolished. The new publication is intended to continue the former one and to present the same subject matter in substantially the same dress. It appears with the approval of the Minister of Public Works, but as a private undertaking. The first number contains an extended study of storage as compared with direct diversion; a table of all dams built or under construction in Italy during 1923, with many drawings and photographs; a

sheet of drawings and a large number of views of the failed Gleno dam, but without accompanying text throwing any light on the failure; and a series of notes and reproductions of new water laws in various countries, besides a list of Italian government licenses and orders relating to water.

MILK PLANTS give rise to one of the most troublesome of the many kinds of wastes that pollute streams in the rural districts. As a contribution to the solution of the resulting problems a well illustrated pamphlet of 188 pages, Studies on Treatment and the Disposal of Dairy Wastes, by C. L. Walker, professor of sanitary engineering, and others, has been published by the Cornell University Agricultural Experiment Station (Ithaca, N. Y.). Fresh milk and whey wastes were studied, with particular reference to fish life and public nuisance. Among the methods of treatment investigated were chemical precipitation; boiling, neutralization of acidity and sand filtration; the activated-sludge process ("not likely to prove practicable"); the septic tank and sand filter.

THE GROWTH OF THE CITY MANAGER PLAN and much pertinent information on the problems and status of city managers are well presented in the Tenth Year Book of the City Managers Association (John G. Stutz, executive secretary, Lawrence, Kans.; 50c). The pamphlet gives revised data up to April 1, 1924. On that date the city manager plan had been adopted by 319 cities of the United States and 7 of foreign countries, the total population of the city manager communities in the United States being nearly 5,000,000; in Canada, 130,000, and in other countries, 470,000. A feature of the Year Book is a directory showing alphabetically by states the cities having managers, with populations, dates plan went into effect, number of managers that have been employed thus far in each city, the name of the manager, the number of cities he has served as such, the date of his appointment in the city now being served, and his salary.

DRAINAGE DISTRICT ASSESSMENT, a study of present practices in assessing benefits under the state drainage laws, by George R. Boyd and R. A. Hart, senior drainage engineers, U. S. Bureau of Public Roads, has been published by the United States Department of Agriculture as a 70-pp. pamphlet which promises to be useful to those concerned with this subject. Land drainage only is considered.

A LARGE IRRIGATION PROJECT IN INDIA, known as the Sukkur Barrage Scheme, is described and discussed in two recent pamphlets. Both are by A. A. Musto, one being entitled, The Future of Sind, and the other, The Sukkur Barrage and New Sind Canal. (C. S. C. Harrison, chief engineer, barrage and canal construction, Karatchar.)

TO PROMOTE FOREST CONSERVATION a paper entitled, Timber: Mine or Crop? by W. B. Greeley and others has been reprinted by the U. S. Department of Agriculture as a separate from its 1922 Year Book (15c. from Superintendent of Documents, Washington, D. C.).

THE SINGLE TAX is the subject of a 53-pp. report of the Committee on Taxation of the City of Toronto. A majority of the committee reported against and a minority for the single tax. Put to vote in Toronto on Jan. 1, the proposal was lost by 37,008 noes to 6,188 yeas.

STUDIES OF IRRIGATION HEADWORKS for the Upper Jhelum Canal at Mangla, are reported in a Punjab Irrigation Branch Paper No. 19 (Lahore, India; 4½ shillings). Altogether the studies cover many years.

GOITER SURVEY OF MICHIGAN is the subject of a preliminary report put out by the Michigan Department of Health (Dr. R. M. Olin, commissioner, Lansing, Mich.). The report shows that in a county where a very large per cent of the entire school population was affected with goiter, the percentage was considerably less in the city of Cadillac, where the public water supply "shows a very slight trace of iodine" than in "the rural districts where there is no iodine."

ROCHESTER, SOUTH BEND AND WEST HARTFORD have recently issued city planning reports. The Rochester report covers the work of its City Planning Bureau from 1918 to 1922. It was prepared by Edwin A. Fisher, superintendent of city planning and consulting engineer to the city of Rochester and was edited by Edward Hungerford. Among the topics covered are city planning in general and in Rochester, transportation, zoning, location of public buildings, water supply, etc. The report contains numerous line drawings and halftones. The South Bend report deals with the major street plan and the West Hartford report with zoning; Harland Bartholomew, of St. Louis, was city planning consultant in each case.

A PROPOSED FINANCIAL PLAN FOR A RAPID TRANSIT SYSTEM in Detroit has been issued by the Rapid Transit Commission of that city. The details of the plan were given in *Engineering News-Record*, Dec. 13, 1923, page 994.

THREE RECENT WATER-SUPPLY PAPERS are: (1) The Occurrence of Ground Water in the United States, with a discussion of principles, by Oscar Edward Meinzer; (2) Summary of Hydrometric Data in Washington, 1878-1919, by Glenn L. Parker and Lasley Lee, prepared in co-operation with the Washington State Board of Geological Survey; (3) the Salton Sea Region, Calif.: A Geographic, Geologic and Hydrologic Reconnaissance with a Guide to Desert Watering Places, by John F. Brown, prepared in co-operation with the Department of Engineering of the State of California. The pamphlets run to some 300 pages or more and are well illustrated. (Washington, D. C.: U. S. Geological Survey.)

New Books and Revised Editions

DRANG UND ZWANG: Eine Höhere Festigkeitslehre für Ingenieure—Von Dr.-Ing. August Föppl, Professor an der Technischen Hochschule in Münschen, Geh. Hofrat; und Dr. Ludwig Föppl, Professor an der Technischen Hochschule in Münschen. Vol. I, Second Edition. Paper; 7x10 in.; pp. 359; 70 line cuts. Paper, 14 marks (gold), cloth, 15 marks (gold), in Germany.

DER EINGELENKBOGEN FÜR MASSIVE STRASSENBRÜCKEN: Eine Statisch-Wirtschaftliche Untersuchung—Von Dr. Sc. Techn. Ernst Burgdorfer, Diplom Ingenieur. Berlin: Julius Springer. Paper; 7x10 in.; pp. 160; 51 line drawings in text and 10 folding plates. $1.80.

ELECTRICAL MEASURING INSTRUMENTS—PART ONE: COMMERCIAL AND INDICATING INSTRUMENTS—By C. V. Drysdale, O.B.E., D.Sc., M.I.E.E.; and A. C. Jolley, A.M.I.E.E. London: Ernest Benn, Ltd. Cloth; 8x10 in.; pp. 440; 377 line cuts and halftones; 37 statistical tables. 55s. in England.

GENERATING ECONOMIC CYCLES—By Henry Ludwell Moore, Professor of Political Economy in Columbia University. New York: The Macmillan Co. Cloth; 6x9 in.; pp. 141; 27 diagrams. $3.

LINE CHARTS FOR ENGINEERS—By W. N. Rose, B. Sc. (Lond.), Teacher of Mathematics at the Borough Polytechnic Institute. [The Directly-Useful Technical Series.] New York: E. P. Dutton & Co. Cloth; 6x9 in.; pp. 95; 47 diagrams, 3 mathematical tables. $3.

Various types of nomographic charts "are introduced progressively," the choice being "such as should appeal to the engineer," the Preface states. Mathematical derivations and construction examples are given. The main divisions deal with charts with (1) straight line axes carrying natural scales; (2) natural scales, but with one axis curved; (3) charts involving logarithmic plotting.

NEW JERSEY COMMISSION GOVERNMENT LAW (WALSH ACT) AND MUNICIPAL MANAGER LAW—By Lewis T. Stevens, Member of New Jersey Bar. Fifth Edition, Revised and Annotated with Court Decisions. Cape May, N. J.: Albert R. Hand. Cloth; 6x9 in.; pp. 170. $2.50.

Forty-four places are listed in this book as having adopted the plan. They range in size from Newark (415,000) to Beachwood (50) by the 1920 Census. The book is useful in New Jersey and, naturally, less useful but still instructive elsewhere because it gives not only the New Jersey commission-plan act but also court decisions on many of its parts. The manager act of 1923, not yet adopted by any municipality and not yet passed on judicially, is included.

DIE PHYSIKALISCHEN UND CHEMISCHEN GRUNDLAGEN DES EISENHÜTTENWESENS—Von Walther Mathesius, Professor an der Technischen Hochschule, Berlin. Zweite, Umgearbeitete Auflage. Leipzig: Otto Spamer. Paper; 7x10 in.; pp. 483; 157 line cuts and halftones. 27 marks (gold) in Germany; cloth, 30 marks (gold).

PORTLAND CEMENT PRICES: Their Basis, Character and Present Position—By Henry Parker Willis, Professor of Banking, Columbia University, formerly Consulting Economist, Federal Reserve Board; and John R. B. Byers, Instructor in Economics, College of the City of New York. New York: The Ronald Press Co. Cloth; 5x8 in.; pp. 123; 16 diagrams and many price tables. $1.25.

STATE AND MUNICIPAL BONDS—By William L. Raymond, Author of "American and Foreign Investment Bonds." Boston: Financial Publishing Co.; London: George Routledge & Sons, Ltd. Cloth; 6x9 in.; pp. 388; many statistical tables. $4.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Has the Type of Pump Anything to Do with Pipe Breaks?

Sir—When it becomes necessary to install new pumping equipment to work in connection with a city water-works, four types of pumps may generally be considered: Steam reciprocating, steam turbine-driven centrifugal, motor-driven centrifugal, and oil or gas engine-driven centrifugal pumps.

In order that a reasonable decision may be arrived at, I believe that frequently, and perhaps generally, a table of comparative costs is prepared. This table includes not only the cost of foundations and building and cost of installation of machinery and equipment, but also allows for the cost of operation, maintenance and depreciation.

As one who has given this subject some study, it occurs to me that not enough attention has been given to the advantage that the centrifugal pump has over the reciprocating pump in that it delivers water without shock or pulsation in pressure. There are few, if any, cities in which a large cast-iron main does not break occasionally and with very few of these breaks is it ever possible to determine the cause. Should a part of these breaks at least be occasioned by water hammer or shocks which originate at the pumping station, then it is surely good engineering practice with new installations to install pumps that will operate without creating such disturbances.

I will be pleased to have you tell me through the columns of *Engineering News-Record* the opinions held by engineers engaged in water-works construction and operation, whether the centrifugal pump with its even discharge at uniform pressure should be given an advantage over the reciprocating pump with its uneven discharge at varying pressures in a comparison of proposals for furnishing pumping equipment.

GEORGE H. FENKELL,
Department of Water Supply, City of Detroit.

Detroit, Mich.,
Feb. 13, 1924.

Stresses in the Rouen Arch

Sir—The design of the French bridge near Rouen (*Engineering News-Record*, March 20, 1924, p. 476) should be a most interesting document. But the few details that have become known are sufficient to decide whether there was any black art behind the closed doors, or whether it could be done by the open door design as usual in this country.

By combining all the available data and applying, e.g. the North Carolina Bridge Specifications, I get the following stresses:

CROWN STRESSES IN LB. PER SQ.IN.

	Upper Fiber		Lower Fiber	
	Max.	Min.	Max.	Min.
Dead-load	+490	+490	+490	+490
Live-load 90 lb. sq.ft.	+180	— 60	+172	— 76
Temp. ±35 deg. F	+113	—113	+146	—146
Total	+783	+317	+808	+268

The conditions at the lowest section of the hollow portion of the rib are less clear, owing to the lack of information regarding the increase in thickness of the rib. The total maximum is about 600 lb. per square inch, the minimum, no tension. The coefficients I used for determining these stresses are based on the assumption of a straight line variation of the value $1/I\cos\theta$; but it seems that the crown section is maintained for a considerable portion of the rib, a fact that will reduce the stresses at the crown and increase them towards the springing, so that the actual extreme fiber stresses may be somewhere around 750 lb. per square inch, the commonly permissible value!

This result is not surprising if we have in mind that the box section of the rib, together with the most ingenious method of bringing it into statical action, represents an ideal scheme for long span arches. The hollow cross-section, besides reducing the dead-load, gives relatively high direct compression and low bending stresses; and by jacking up the rib instead of lowering centers, the stresses due to rib-shortening (which in this case would be about equivalent to 30 deg. drop in temperature) shrinkage and initial settling of the abutments are eliminated. So, too, are the strongest arguments usually advanced by the opponents of scientific arch design. Furthermore this method, together with a convenient shape of the arch, permits any desired dead-load thrust line, so as to compensate the extreme fiber stresses where necessary.

After all it is evident that there is no reason why an arch of these dimensions could not be built in this country following our specifications, which compared with some European ones are rather conservative.

Still the editor is right, if he prophesies some bad nightmares to the designer of such a bridge; that is with regard to the lateral stability of the ribs. In Merriman's handbook we find under "arch failure—as a column," when the ratio of the unsupported length of an arch to its least width is greater than 12. In order to apply this coefficient in our case of a hollow rib we introduce the radius of gyration r and we have

$$L/r = 12\sqrt{12} = 41.6$$

There are several examples of known arches, where this ratio is higher, but for this new bridge, taking the unsupported length between the cross ties only, we get $L/r = 110$ and this in the definite structure, with the full allowable compressive stress!

Here is the point where this bridge sets the most remarkable record, and we heartily congratulate the French engineers upon their boldness and—good luck.

ARNOLD ESCHER,
Raleigh, N. C., North Carolina Water Highway Dept.
March 28, 1924.

Reservoir Stripping at Birkenhead

Sir—We have read the editorial in your issue of March 13, p. 435, headed "A Costly Mistake." As we are the engineers who were responsible for the design and supervision of the construction of the work in question, we think it desirable to bring before you certain facts with regard to Mr. Jackson's statement regarding water-works improvements at Birkenhead, England.

An account of Mr. Jackson's lecture appeared in the Birkenhead *News* and the Liverpool *Post and Mercury* and directly it was brought to our notice we wrote to Mr. Jackson as per enclosed copy of our letter dated Feb. 18. Mr. Jackson replied sending us a draft of a letter to be sent by him to the two newspapers concerned. We approved the draft, and we enclose herewith a copy of Mr. Jackson's letter. As the publication of an article such as that which appeared in your columns may well be very prejudicial to our firm, we should be extremely obliged if you would be good enough to publish the correspondence just mentioned.

SIR ALEXANDER BINNIE, SON & DEACON
Westminster, England, BY MARTIN DEACON.
March 25, 1924.

[A letter of correction on this subject by William Gore, Toronto, Ont., formerly chief assistant engineer to the late Dr. G. F. Deacon and his successors, Sir Alexander Binnie, Son & Deacon, appeared in these columns, March 27, p. 542.

The Mr. Jackson mentioned is chairman of the Water Committee of Birkenhead. The comments in our columns were based largely on an article in the London *Surveyor*, credited in turn to the Birmingham *Post*, containing the following statement ascribed to Mr. Jackson: "In view of the engineers' advice at the time, said Mr. Jackson, he did not blame the Water Committee for deciding upon the removal of the peat. The cost of the removal was £100,000, and had it not been for the delay thereby occasioned, we should probably have had the dam completed and the pipe line either completed or in a forward condition before the War broke out."

Mr. Deacon's letter to Mr. Jackson, after introducing statements and citation of the immediately foregoing paragraph, says:

"Owing to the very serious delays in completing the Alwen scheme, the whole project very much exceeded

the original estimate and the newspaper account may be construed to mean that, not only were the engineers responsible for the extra expenditure upon the unnecessary removal of the peat, but that, as the removal of peat delayed the works, they are also responsible for the extra cost of the work as a whole. The facts are as follows: Before it was decided to use mechanical filters, the advice given to the corporation [Town of Birkenhead] was that the whole of the peat should be removed. When mechanical filters were decided upon, we advised the corporation—by our letter dated May 10, 1910—that there was no necessity to remove any of the peat from the upper half of the reservoir, thus incurring a saving of something like £70,000. The corporation did not accept our advice, and took upon themselves the sole responsibility for the extra expenditure.

"So far as delays were concerned, the removal of the peat had no influence whatever. The class of labor engaged on the peat was of a totally different nature from that required on the dam, and, even if no peat at all had been removed, the position as regards delays would have been just the same.

"As this matter has now appeared in the newspapers, and thus become public property, we should be glad if, without delay, you would write to the press, asking them to publish the fact that the engineers were in no way responsible for the unnecessary expenditure on the peat, and, further, that the removal of the peat had no bearing whatever upon the delay in completing the works which was entirely due to the War."

Mr. Jackson's reply to Mr. Deacon's letter, as published in the Liverpool *Post and Mercury* of Feb. 22, follows:

"In your issue of Feb. 12 you published a summary of a paper read by me before the Birkenhead Literary and Scientific Society on the Birkenhead water supply. In it I said 'that, in view of the engineer's advice at the time, I did not blame the Water Committee for deciding upon the removal of theh peat.' It has been suggested to me that this might imply that I did blame the engineers, and, as nothing was further from my thoughts, I trust that you will publish this explanation.

"The Water Committee at first decided on gravity filters (mechanical filters being then still somewhat in the experimental stage), and, in view of this, the removal of the peat was a necessity and the engineers were bound to advise its removal. When, in 1910, the committee decided upon mechanical filters, the engineers at once wrote advising that there was no necessity to remove any of the peat from the upper half of the reservoir.

"It has also been pointed out to me that the labor engaged on the peat was of a totally different nature from that required on the dam, and therefore, that the removal of the peat had in fact no bearing whatever upon the delay in completing the works, which was entirely due to the War."

We were quite unaware that any of the engineers named above were connected with the Birkenhead work.—EDITOR.]

Tremie Concrete and Laitance

Sir—D. A. W.'s letter in *Engineering News-Record* of Mar. 20, p. 501, on "Laitance Dangerous in Under-Water Concrete," advances the theory that laitance possibly caused the breaking of the foundation seal of the Lewis & Clark bridge pier. However, in describing the case originally, C. B. McCullough stated (Mar. 13, p. 460) that the concrete foundation seal for this bridge was placed in one continuous operation and that only once was the charge in the tremie lost.

In placing under-water concrete by the tremie method it has been the writer's experience that the lower end of the tremie pipe during the period of concreting is embedded in the fresh concrete from 3 to 8 ft., depending on the area of concrete surface and the number of tremies, and each batch of concrete fed through the tremie enters the mass of concrete below the surface exposed to the water. My conclusions are that properly placed tremie concrete will not permit any laitance seams to form, and that the failure at the Lewis & Clark bridge should not be attributed to laitance. I believe D. A. W. has confused the placing of under-water concrete with bottom-dump buckets with tremie deposition.

Additional information from Mr. McCullough would enlighten your readers as to the cause of the failure, what provision was made to equalize the water level in the cofferdam with the river that was subject to a 13-ft. tide, what height of cofferdam was exposed to winds at low tide, and to what wind and wave action the cofferdam was exposed for the five-day period after the seal was placed.

Hudson, N. Y., April 1. G. A. GRAHAM.

Laitance Layer Caused Failure of Cofferdam Seal

Sir—The wreck of the cofferdam due to the splitting of the concrete seal in a large pier foundation, described in your issue of March 13, p. 460, it seems to me can only be accounted for by the known tendency to the accumulation of a deep layer of laitance on the surface of concrete as it is being deposited in or through water. Other failures have taken place which have been the result of this action.

The layer of laitance, which is the cream of the cement, washed out by the action of the water, is frequently found to be several inches thick. This substance, while it is the active part of the cement, when allowed to be segregated has two detrimental effects. First, its loss from the mixed concrete weakens that concrete, as it takes away a portion of the cement. Second, the layer of laitance is a layer of no strength, just as a thick layer of glue would be of no value to hold wooden blocks together. Besides this, where waterproof quality is needed, the layer of laitance affords unobstructed entrance to water.

It is only necessary to assume that in pouring this pier, after a part of it was poured and a thick layer of laitance had accumulated, the next layer of concrete was deposited on top of this laitance to account for the subsequent separation of the concrete block in an almost horizontal plane.

Pittsburgh, March 19. EDWARD GODFREY.

Concrete Roads and Recent Research

Sir—In the past year many interesting reports pertaining to highway research and investigations and to concrete pavements in particular have appeared in your columns. Most of these articles contained valuable information with the aid of which highway engineers began rationally to design pavements. In the majority of these articles there seemed to be no doubt but that concrete will solve the highway problems of the future.

In *Engineering News-Record*, March 6, 1924, p. 418, Mr. Carmichael wishes to inform engineers that black top pavements on bases other than concrete are preferable to concrete pavements because: (1) they are cheaper; (2) they have been in use many years and are therefore better known; (3) there is at present a greater mileage of the black top variety than concrete. The last two are very poor arguments in favor of the black tops.

I agree with Mr. Carmichael that black tops may be cheaper than concrete, but durability and desirability will far outweigh a small difference in cost. Who would compare the strength of bituminous pavements with that of concrete? How long could the former type last with the modern heavy traffic pounding away at it before it would have to be renewed or replaced with the rigid type of pavement? Contrary to the general belief, the highway problem looms large, not because engineers have been asleep, but because the automobile industry has jumped, by leaps and bounds, ahead of highway development. The big problem that must be solved is to counteract the effect of impact blows delivered to the edges of pavements by heavy, fast moving loads. Such loads would disintegrate a bituminous type of pavement (not on a concrete base), whereas they would cause only a crack in a rigid pavement.

Perforce, it must be admitted that the present mileage of the black tops exceeds that of concrete. However, Rome was not built in a day. Give concrete a chance—it was first used about fifteen years ago, so it is quite natural that there should be a larger proportion of black tops. It would be interesting to know the percentages of various types of pavements used in the various state systems throughout the country this year and learn just how important a place concrete pavements hold.

Most of the concrete roads still present better riding surfaces than other roads of the same age, in spite of the fact that very little was known about concrete for highways even five years ago. I have ridden over many miles of con-

crete pavement almost ten years old in New York State and conclude that they are far superior to the other types. Mile after mile of this concrete is just as good as it was when laid years ago. Even the original finishing broom marks are plainly visible. In some instances a very thin scale is peeling off the surface and a coating of bituminous material ¼ in. thick serves to protect it against further peeling which, once started, is accelerated by horse-drawn and steel-tired traffic. An effort is being made to determine the cause of this peeling.

Mr. Carmichael also states that no two authorities seem to agree on a standard type of pavement or the method of reinforcing, if indeed, the latter is to be used at all. The authorities referred to are Mr. Goldbeck of the U. S. Bureau of Public Roads, Mr. Older of Illinois and Major Besson of the District of Columbia. Mr. Goldbeck is inclined to believe that the design described by Mr. Burr in *Engineering News-Record*, Jan. 10, 1924, p. 78, would give a good account of itself. Mr. Older does not discuss the merits of this design, but states that two of the assumptions on which it is based are wrong and therefore the design is invalid. The Bates Road proved to Illinois and the rest of the country that corners, edges, and joints are sources of weakness in a slab, because after the test the standard 1922 Illinois section was changed to one similar to Mr. Burr's insofar as the places of weakness are strengthened by thickening of concrete or by the addition of steel bars. More anon concerning Mr. Burr's design.

I agree with Mr. Carmichael that some authorities responsible for certain standards in their respective states seem to sanction diametrically opposed standards. It happens too frequently that competent engineers are not in a position to decide the issue of adopting a standard section. How often is a standard adopted on the word of an official who is not an authority?

Let us analyze the results of the Pittsburg Test Road where, apparently, the plain concrete sections withstood the heavy traffic better than the reinforced sections and see whether Major Besson is justified in advocating concrete without reinforcement. Before we actually compare these sections, a word concerning the above mentioned discussion by Mr. Goldbeck anent the design of Mr. Burr's would not be amiss. Too much cannot be said about the importance of the results obtained with the Goldbeck Graphic Strain Gage and shown graphically in *Engineering News-Record*, Jan. 10, 1924, p. 80. By means of this gage, the variation of strain is accurately measured in any part of the road slab under static, moving or impact loads. It is now known definitely that the greatest stress (or strain) is produced when the load is on the edge of the slab; and this produces a tensile stress in the bottom of the slab. In only one case does the maximum tensile stress occur in the top of the slab; that is, either when the load is placed at the corner formed by the intersection of the edge with a transverse joint and the subgrade is in a plastic condition, or the slab curls up on account of the difference in temperature between the top and bottom of the slab. Then the corner acts like a cantilever and only then is the maximum tensile stress in the top of the slab comparable to that in the bottom. After a few repetitions of the load, the slab is pressed down into contact with the compacted subgrade and the resulting tensile stress in the top becomes negligible. Tensile stresses due to negative bending moments along the top edge of the slab are also negligible. Hence it can be seen why reinforcing steel must be placed in the bottom of the pavement to prevent cracking. The graphic strain gage also proves that the inner portions of a slab need not be designed as strong as the edge or transverse joint.

Now it is obvious why the plain concrete sections showed up stronger than the reinforced sections in the Pittsburg Road. The reinforced sections (C, D, K, G) were not logically reinforced. If more of the steel were placed longitudinally and nearer the edges and joints, these sections would have held up just as well, at least, as the plain sections. On the other hand, the plain sections (J, F, E, M) were of the thickened edge type. Here the concrete was placed where it would do the most good; it gave greater rigidity to the edge of the slab and consequently, reduced stresses. The amount of concrete placed in these ribs or thickened edges varied from 36 to 96 sq.in. If a proportionate amount of steel were used for marginal reinforcement on the bottom of the slab, it is logical to assume the strength of the slab would not have been decreased.

Many states have adopted standard sections having steel reinforcement in the neutral plane of the slab. It is difficult to understand the theory back of such a design—unless the steel bar or wire mesh reinforcement was intended to act merely as a bond. Three sections (B, H, I) of the Pittsburg Road were thus reinforced and failed miserably under the traffic. If temperature stresses are the predominant cause of failure, the top of the slab should be reinforced, but if tensile stresses in the bottom of the slab are the cause of failure, then the reinforcement should be placed at the bottom. Although it is not definitely known which of these two stresses is the more serious, one cannot help intuitively stating that traffic stresses are more severe. It is apparent that placing steel in the center of the slab has extremely little effect in reducing these stresses.

Practically all cracks caused by temperature stresses will appear within twenty-four hours after placing the concrete—especially during the time of setting. If a moderate amount of surface reinforcement does not prevent temperature cracking—and I have seen slabs reinforced with 50-lb. mesh crack irregularly across the entire surface—then the next best thing to prevent failure is the marginal steel placed on the bottom of the slab.

Mr. Burr's design is the most logical one that has been proposed, inasmuch as he puts to practical use the knowledge obtained from the various test roads. Most of his marginal steel is placed in the bottom of the slab and the corners are strengthened by the bending up of some of the reinforcement. No doubt the use of a longitudinal joint would eliminate the necessity for reinforcing the inner portions of the slab, and the steel could be more satisfactorily used for temperature stresses in the top of the slab. In addition to preventing unsightly longitudinal cracks, the longitudinal joint possesses an inherent advantage of serving as a guide for motorists.

A great deal of credit is due the authorities back of the Pittsburg and Bates road tests, and the U. S. Bureau of Public Roads in particular, for the remarkable progress made and the comprehensible results produced in the field of highway research during the past few years.

New York, N. Y. A. J. DONARGO,
March 25, 1924. Civil Engineer.

Belling the Pedestrian

Sir—The *Highway Builder* for March, 1924, on p. 34 under the heading of "News Notes" prints the following:

"Advocates Lights for Pedestrians on Highways.—Professor A. H. Blanchard, head of the Department of Highways Engineering at the University of Michigan, proposes for legislative action next year the following regulations.

'All pedestrians walking or standing on roadways or highways outside of incorporated villages or cities, shall walk or stand on the extreme left side of the roadway and shall, during the period from one hour after sunset to one hour before sunrise, carry a white lantern, except in the case of two or more walking together, in which case only one lantern may be carried, which shall always be displayed in such manner as will be visible to approaching vehicles.'—Michigan Roads and Pavements."

"By doubting we come to know the truth." May we, therefore, ask:

What is the extreme left of a roadway when a pedestrian is "standing" on it outside of a village or city?

Must the lantern be all white?

Must the lantern be lighted?

What is the ordinary "visibility" of modern vehicles; for instance, how far may a vehicle be expected to see or identify a "white lantern" (only motor vehicles need answer)?

Captiousness is not intended above. But the necessity for clear expression in statutes probably needs no argument. And while a revision of the stated proposition may be under consideration, why not contemplate the addition of a provision requiring all persons walking, standing, or riding "on highways outside," etc., each to wear an exposed luminous sleeve on his or her right arm so that in case the "white lantern" were blown out or the driver were steering with his left arm only (his right being otherwise occupied), "approaching vehicles" and others might recognize the circumstances, perhaps to mutual benefits? W. W. CROSBY.

Harrisburg, Pa.,
April 11, 1924.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Collusion Suspected in Portland Bridge Awards

Special Jury Investigating Three Contracts, Now Rescinded—May Recall Officials

Special Correspondence

Suspicion that there has been collusion and possible graft in the bridge-building program of Portland, Ore., has started a grand jury investigation under the direction of special investigators appointed by the governor.

Bids were opened on April 1 for three new bridges across the Willamette River, the aggregate cost of which was to be met by a $4,500,000 bond issue voted some time ago. Two bids were received on the Burnside bridge, and one each on the other two. J. H. Tillman, who bid on the Burnside bridge, Parker and Banfield, who bid on the Ross Island bridge, and the Union Bridge Co., bidding on the Sellwood bridge, were associated, and each conditioned his bid upon acceptance of the bids of his associates. The bid of the Pacific Bridge Co., the second Burnside bridge bidder, was $530,000 lower than that of J. H. Tillman, yet the county commissioners, against the advice of the county attorney as well as that of Hedrick and Kremers, the bridge engineers, awarded contracts for all three bridges to Tillman and his associates six hours after the bids were opened. This action raised a storm of public protest and four days after the awards were made the commissioners rescinded the awards.

Recall Petitions Circulated

Petitions were immediately circulated for the recall of all the county commissioners; and more than enough signatures were secured to place the recall measure on the ballot at the primaries on May 16.

The scope of the grand jury inquiry being large, investigation will also be made into the selection of the bridge engineers. In January, 1923, R. E. Kremers, an assistant in the city engineer's office, was selected by the county commissioners as the bridge engineers. Public protest on account of his inexperience in bridge work led the commissioners to modify that action, and later Ira G. Hedrick formed a partnership with Mr. Kremers, and the contract for engineering services was given the following March to Hedrick and Kremers.

The special investigators are also carrying their inquiry into other acts of the city and county officials in connection with alleged irregularities in insurance and surety bond matters. County Commissioner Dow Walker is a member of an insurance firm which has received a large share of city business and Mayor George L. Baker is charged with being a silent partner in another firm which secured much of the county's business.

Investigation is as well being made of alleged private purchase through agents by city and county officials of property that will be required for bridge approaches. In the meantime no progress in bridge construction appears possible until the result of the recall election is known. Several substantial business men have been drafted to run at the recall election for county commissioners.

The Oregon Technical Council has led public protest against the appointment of inexperienced engineers, against the award of contracts to the high bidder which appeared against public interest, and against the unbusinesslike methods pursued by the county commissioners. At the first the public appeared indifferent, but the investigation now under way vindicates the demand for clean government and businesslike methods of governing officials.

New Orleans Engineers Give Entire Radio Program

Engineers of the New Orleans chapter of the American Association of Engineers, recently took charge of an entire evening's broadcasting program. Subjects were all of a civic nature and included a talk on "The New Orleans Industrial Canal," by A. M. Lockett; "Good Roads Movement in Louisiana" by James M. Fourmy; "Sewerage, Water and Drainage," by George G. Earl; "Landscape Engineering" by D. G. W. Ricketts; and "The Engineer, Aims and Ideals of the American Association of Engineers," by Elbert G. Sandoz. The program was interspersed with musical numbers and was given before a large number of engineers.

War Department Asked to Approve Golden Gate Bridge Plans

The two counties bordering the narrow entrance to San Francisco bay known as the "Golden Gate" have joined in submitting plans to the War Department for a bridge to span this mile-wide waterway and asking for permission to build such a structure.

Marin and San Francisco counties, the two directly concerned, in conjunction with other counties that would also benefit, are acting under an enabling act passed by the California legislature to provide for co-operation in inter-county bridge work. Reference to the proposed structure, which would have the longest span yet attempted, was published in *Engineering News-Record*, July 5, 1923, p. 34, and July 19, 1923, p. 86. It is expected that the War Department will authorize a hearing on the application in San Francisco some time in the near future.

A. P. Davis Favors Boulder Canyon Project

Former Reclamation Bureau Head Opposes Proposals to Start Colorado Development at Mohave

Washington Correspondence

Testifying before the House Committee on Irrigation, A. P. Davis, former director of the Reclamation Service, declared that the Boulder Canyon site is the hub around which all the hydro-electric and irrigation development of the Colorado River should be built. Mr. Davis declared that work at Boulder Canyon could be done at greater speed and less cost than at any other feasible site on the river and that all other developments would fit in with the initial work at this site.

Mr. Davis vigorously opposed the proposals that development of the Colorado River start with a flood-control reservoir at Mohave, asserting that this proposition should be dismissed because it presented what he described as "endless opportunities" for delay and, he asserted, would be "inexcusable from every point."

Mohave Site Opposed

The topography at Mohave is such that a dam there would be unfeasible for power development; the stored water would be susceptible to evaporation; and the entire project would be more expensive than similar work at Boulder Canyon. Mr. Davis declared that the Mohave site is low, hot, shallow and exposed to wind, and therefore, is unsuited for water storage. The Boulder Canyon site, he asserted, affords opportunities for a deep, narrow reservoir that would not present difficulties of this character.

George H. Maxwell, executive director of the National Reclamation Association, on the other hand criticised the Boulder Canyon proposal, in his testimony before the Committee.

Steps to protect Imperial Valley in California against flood waters should be the outstanding consideration in the development of the Colorado River, Mr. Maxwell urged. He declared that the committee shou.d eliminate every other factor until flood control means have been devised.

Spavinaw Overflowed 26 Days After Gates Closed

Just 26 days after closing the gates of the Spavinaw Dam, recently completed, the reservoir at the upper end of a 55-mile pipeline to Tulsa, Okla., was filled and water for the first time overflowed the spillway. While the reservoir was filling a pipeline crossing under the creek below the dam was completed by working day and night.

Senate Committee Hears Hooker Shoals Offer

Return to Government of $305,000,000 Under Hooker-White-Atterbury Offer Declared Possible

Washington Correspondence

Proponents of the Hooker-White-Atterbury bid for the Government's projects at Muscle Shoals occupied the greater part of the time of the Senate Committee on Agriculture and Forestry, during the first week of the hearings before that body. The so-called Hooker bid provides for a partnership arrangement between the proposed corporation and the government with control in the hands of the corporation.

Explaining his bid, Elon H. Hooker, who is president of the Hooker Electrochemical Co., and also president of the Manufacturing Chemists Association of the United States, declared that it would give a greater return to the government on the investment than any other proposal which has been made. He also asserted that the company proposed research to develop a highly concentrated fertilizer which, he said, would save farmers $30,000,000 a year on their purchases and give the government, in connection with other operations, a return of $305,000,000 in fifty years.

Atterbury Testifies

W. W. Atterbury, vice-president of the Pennsylvania R.R., who is associated in this bid, told the committee that his interest in Muscle Shoals was the possibility in his mind of developing plants for the production of a metal akin to aluminum, but lighter and more durable than aluminum, at low cost. He described this metal as an alloy of aluminum and magnesium, saying it formed the framework of the German zeppelins used during the World War. He is interested in the development of this metal at low cost, Mr. Atterbury said, because of the possibilities of using it in the construction of passenger and freight cars and locomotives.

J. G. White, the third associate in this offer, estimated to the committee that current at Muscle Shoals should be sold at about $20 to $40 per horsepower-year as a fair estimate on a 40 per cent load factor and on that basis, calculating 200,000 hp. hydro-electric supplemented by steam plants, the income to the government should be about $6,000,000 a year.

Ford Bid Assailed

F. R. Weller, consulting engineer for the Hooker bidders, assailed the offer of Henry Ford for Muscle Shoals as violative of the Federal Water Power Act. He also criticised the offer of the associated southern power companies, on the ground that they could not dispose of the power with the same financial return to the government that a private corporation consuming this power could do. Basing his figures on 56 years, that is six years for continual construction and fifty-year lease thereafter, Mr. Weller declared that under the Ford offer the return to the government would be $90,980,000; under the power companies' offer $136,400,000, and under the Hooker-White-Atterbury offer, $305,165,000. The last,, he said, is the only offer that purports to give the government an adequate return on its investment of public money.

The Hooker bid was declared the most fair that has been submitted in the testimony of Hugh MacRae of Wilmington, N. C., who particularly criticised the Ford offer and that of the power companies.

R. D. Bowen, national lecturer for the Non-Partisan League, told the committee that if Henry Ford obtained Muscle Shoals on the offer that has passed the House, Congress would be "selling the Nation's birthright." O. F. Graff, president of the American Nitrogen Products Co., Seattle, Wash., told the committee that he opposed the Ford bid and all the other bids, because on their terms no private enterprise could compete with the company getting Muscle Shoals.

Senator Ralston declared before the committee Friday that it was his opinion that all the pending bids should be set aside and that the government first should adopt a definite policy towards Muscle Shoals and then call for bids to execute this policy. Chairman Norris said that he saw no objection to this idea and that he understood that it conformed to the suggestion of president Coolidge as expressed in his message to Congress.

Important Organization Changes in Reclamation Bureau

Separation of financial matters from engineering and operation in the Bureau of Reclamation, U. S. Department of the Interior, which was announced at the time of the appointment of Dr. Elwood Mead as commissioner of reclamation (April 10, p. 630), has been supplemented by some related changes made in an order issued April 9. This order establishes several new titles, as follows: The new position of director of finance is created; the field commissioner is designated director of farm economics; project managers are designated superintendents of ditches; the position of chief field counsel, with office at Denver, is created; project chief clerks are designated chief clerks of irrigation districts.

With this order the work of the renamed field commissioner (at present Miles Cannon) is changed to give him charge of crop production, handling and marketing, improvement of farm conditions, industrial betterment, and settlement of lands. Operation of the projects is returned to the engineering department. The chief engineer is to direct all engineering, construction, maintenance and operation of the irrigation works. Collection of water charges and all other financial matters, however, are placed under the new director of finance. The relations between the engineering and operation officials and the settlers will therefore not be affected by questions of payment. Collections will not be handled by the superintendents of ditches (former project managers) but by the chief clerks, reporting to the director of finance.

Politics Causes Upheaval in Arizona Engineer Services

Special Correspondence

Friction between political friends of Governor Hunt, of Arizona, and engineers in state service has ended in the resignation of Frank R. Goodman, state engineer, and a general upheaval among engineering forces. The culmination of difficulties came recently through actions of the governor's former campaign manager, now secretary of the board of directors of state institutions, in handling affairs of the highway department, of which he had been given complete control. Mr. Goodman openly charged in a letter to the press that the secretary of the board is without knowledge or experience and was using the highway department as a tool for building up political power.

Part of the friction was caused also by Mr. Goodman's opposition to the secretary's announced policy of doing all work by day labor. Last June Mr. Goodman resigned but the governor refused to accept his resignation, reiterating his confidence in Mr. Goodman's integrity and ability as an engineer.

When placed in charge of the highway department the secretary of the board immediately inaugurated a retrenchment policy, discharging chiefly engineering personnel. Mr. Goodman construed such action as an attempt to embarrass him and force his resignation in order to carry out his, the secretary's, policy.

It was said the office was tendered W. W. Lane, who declined unless he be permitted to have full control. Subsequently Mr. Lane resigned and it is rumored other important attaches are to be replaced, which may mean the disintegration of the highway organization.

Capital Bridge Plans Approved

Plans for the construction of a memorial bridge across the Potomac River between the Lincoln Memorial and the Arlington National Cemetery in the District of Columbia, and the development of the territory adjacent to both sides of the proposed bridge at a total cost of $14,750,000 were approved recently at a meeting of the Arlington Memorial Bridge Commission held in the White House with President Coolidge presiding.

Bills providing for this project, the greatest of its kind in recent years in the national Capital, will be immediately introduced into the House and Senate.

The plans call for the expenditure of nearly $15,000,000 within a period of ten years, work to begin immediately. The money will be used as follows:

Memorial bridge proper	$7,250,000
Bridge plaza and water gate	1,000,000
Columbia island	2,880,000
Parkway and memorial entrance to cemetery	1,390,000
Extension of B Street eastward to Capitol and widening to 120 feet	2,070,000
Widening Twenty-third Street from Washington Circle to B Street	160,000
Total	$14,750,000

Kansas City Water-Works Construction Stopped

All Activities Under Fuller & Maitland Contract for Engineering Services Enjoined by Federal Judge

Special Correspondence

All construction and other activities on the extensive undertaking for a new water supply for Kansas City, Mo., including the award of proposed contracts for tunnel construction at a total price of nearly $3,300,000, were halted by vote of the Fire and Water Board on April 18, following a temporary injunction issued by a federal judge April 14. The decision hinges on language in the contract for engineering services between the city and Fuller & Maitland, which describes the project as new water-works construction, whereas the city charter, the federal judge holds, gives authority for extensions only.

The situation created by the injunction was complicated—or simplified, according to the point of view—by the fact that the city administration responsible for the Fuller & Maitland and other contracts, let and proposed, lost the election on April 8 and was succeeded by its successful rivals on April 21, who, it is understood, have no disposition to carry the suit through the courts. This leaves the burden of the suit on Fuller & Maitland, whose commission of 9½ per cent on the cost of the new works has been characterized by the opposition as exorbitant, and on the contractors.

The movement for a new water supply at Kansas City goes back several years. Late in 1920 Fuller & McClintock, New York City, made a report on water-works improvements to the Fire and Water Board in which it was estimated that improvements needed within six to eight years would cost from $14,000,000 to $18,000,000 at prices then current. The recommendations of this report were endorsed by the board of engineers consisting of Wynkoop Kiersted, Clinton S. Burns, George A. Johnson of Johnson & Benham, Alexander Maitland, Jr., and John Prince, who advised a bond issue of $18,000,000 to be expended by a non-partisan water board (See *Engineering News-Record*, Oct. 28, 1920, p. 865, Jan. 6, 1921, p. 44, and March 4, 1921, p. 499).

Later a Water Supply Committee of Twenty-Five endorsed the recommendations for a non-partisan board and the general project but on the basis of fall of prices reduced the estimated cost to $11,000,000 (*Engineering News-Record*, May 26, 1891, p. 915). On Nov. 22, 1921, the voters elected a non-partisan water board of four members (including Mr. Maitland, president of the Kansas City Bridge Co.) but a proposed water bond issue of $11,000,000 lacked the legal majority of two-thirds, although receiving an actual majority. The defeat of the bonds was attributed to uncertainty as to election of a non-partisan board but with such a board in existence the bonds were voted, 4 to 1, on April 4, 1922. Soon afterwards a freeholder brought suit to have the non-partisan board thrown out and the State Supreme Court ruled that the creation and election of the board was unlawful. The proposed improvements were then taken up by the Fire and Water Board which engaged Fuller & Maitland as engineers, under the contract already mentioned.

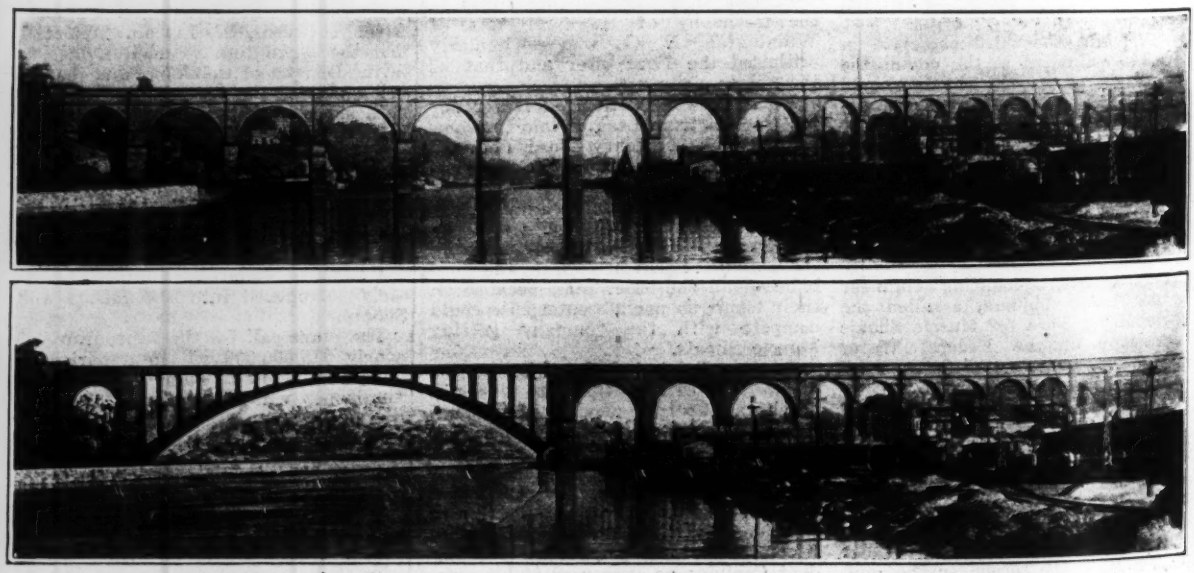
One of the points under discussion was whether the old plant (in Kansas) should be extended or a new plant on the Missouri side of the river should be constructed. Joint resolutions were passed in both state legislatures and ratified in Congress for reciprocal exemption of city property in either state from taxation by the other but Fuller & Maitland finally recommended a new plant on the Missouri side at a cost of $11,000,000 *without filters*, and estimated that an ultimate expenditure of $20,000,000 would be necessary before the plant with filters could be completed. The estimated cost given in Fuller & McClintock's original report was about $18,000,000 for the complete plant, which was cut to $11,000,000 by the local board in anticipation of reduced construction costs in 1921.

Plans have proceeded and bids were received a few weeks ago for constructing a tunnel to the existing and to a proposed new pumping station. Contracts had already been let for grading at the plant, principally for relocation of the St. Joseph electric line, which crossed the site, for some pipe and for a pump. Contracts for tunnels were awarded by the Fire and Water Board directly after the election on April 8 but had not been confirmed by the council when the suit already mentioned was brought in the Federal Court to enjoin all further work, including engineering. Of the two tunnel contracts that covering the main tunnel was awarded to Tibbets & Pleasant, Tulsa, Okla., and the one for the two branch tunnels to Byrne Brothers, of Chicago.

Plans for Changes in High Bridge at New York Approved

The approval by the Municipal Art Commission of the plans for the alterations in High Bridge over the Harlem River at New York marks the successful conclusion of the attempt to save that historic structure from complete destruction. Engineers were among the chief exponents of the preservation of the bridge and it was largely through their efforts that the city authorities were convinced that the bridge could be altered to suit the new conditions at less cost than for its complete removal and the construction of a siphon under the river to replace it.

The removal of the piers from the Harlem River is a part of the plan now being executed improving its channel. The piers at the bulkhead line will be rebuilt and lengthened to provide abutments for the new steel arches, and after the steel arches have been erected outside of the present stone ones the latter will be removed. In all, four piers and five arches will be removed.



HIGH BRIDGE, NEW YORK CITY, WITH SKETCH (BELOW) OF RECONSTRUCTED CHANNEL SPAN

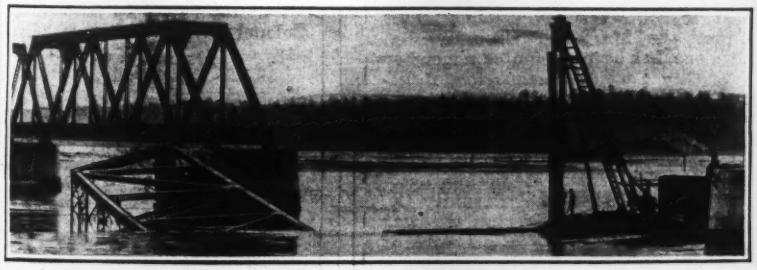
Bridge Span Pushed From Piers by Small Steamer

As reported in *Engineering News-Record* of March 27, p. 543, a small lumber schooner on March 8 struck one of the fixed spans of the Coos Bay bridge of the Southern Pacific R.R., in Oregon, and knocked the span off its piers. Photographs showing the bridge and the steamer have since become available, as reproduced herewith. They bring out very clearly the extensive damage to the bridge and the practical absence of damage to the steamer. The vessel is of wooden construction, 193 ft. long, of 780 tons gross register, while the steelwork of the wrecked span weighs about 219 tons.

At the time of the collision the steamer was about in the position of the piledriver shown in the upper of the three accompanying views. The span in question is alongside the draw span, and the steamer missed the channel through the open draw and struck the adjoining fixed span at the second panel point from the draw span pier. The impact of the collision carried this end of the span, which was the fixed end, off its pier and turned the span on its side. In this position the sharp edge of the shoe at the roller end of the span dug into the concrete of the pier and cut down through it as shown in one of the views, dropping this end of the span to the position shown, where it rests on the base of the pier and on what remains of the old pier cofferdam.

The end of the span nearest the draw is completely submerged; the steamer ran up on this part of the steelwork, but was pulled off easily. Examination of the steelwork by divers shows very little damage, and it is expected that the span can be raised bodily, placed on falsework, and repaired, prior to being set back in place.

At the expansion end, where the corner of the pier was damaged by the overturning span, the shoe which is now uppermost carried the bed plate and rollers with it, while the other shoe tore away from the bed plate; it is believed that the edge of the latter shoe was the cutting edge which plowed out the end of the pier.



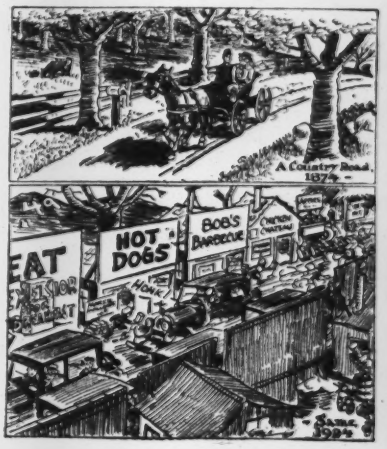
RESULTS OF COLLISION BETWEEN BRIDGE AND STEAMER
Upper view, wrecked span seen from fender pier of draw; at left below, end of concrete pier plowed out; at right below, dent in bow of steamer.

Maryland Bond Issues Many

The session of the Maryland Legislature recently adjourned authorized over twenty bond issues, totaling $18,500,000 for sanitary improvements in the various municipalities of the state. The largest of these was $10,000,000 for sewerage extensions, etc., at Baltimore. This bond issue, however, like a number of others in the list, requires approval by referendum vote. The next largest specific items were $750,000 for water-supply improvements at Cumberland; $550,000 for water, sewers and drains at Salisbury, and $500,000 for water and sewers to be built by the Washington Suburban Sanitary Commission.

Random Lines

"Whither Are We Drifting"



This Arrived Too Late For Our Fiftieth Anniversary Issue
From the San Francisco *Chronicle*

* * *

Construction News

Senate Bill No. 1969, State of New York. Introduced April 8, 1924 by Mr. Robinson:

An Act

Authorizing the construction of a foot bridge across the interior court of the capitol building at the third floor with movable sidewalks running north and south connecting the senate and assembly, and making an appropriation therefor.

In order to discourage congestion of traffic in the capitol building lobbies during sessions of the legislature it is hereby declared by the legislature to be for the public interest that a foot bridge should be constructed and the superintendent of public works is hereby directed to construct a foot bridge with movable and moving sidewalks running north and south to and fro from the senate chamber to the assembly chamber over the court of the third floor of the capitol building, for the exclusive use of newspaper representatives, lobbyists, employees of the state and the general public. Such bridge shall be built without any railing so as to discourage loitering thereon and shall be protected by state policemen stationed at appropriate intervals to regulate traffic and to preserve the balance of passengers.

The sum of $600,000 is hereby appropriated to build such bridge. Such money shall be paid out on vouchers approved by the state lunacy commission in the manner provided by law and the bridge when finished shall be under the control and custody of the senate and assembly pages.

This act shall take effect immediately and the superintendent of public works is directed to sleep on the bridge nights until it is completed.

Engineering Societies

Calendar

Annual Meetings

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Atlantic City, N. J., May 13-15, 1924.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, New York City, May 19-24, 1924.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Meeting, San Francisco, Calif., June 11-13, 1924.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Convention, June 18-20, Pasadena, Calif.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, Atlantic City, N. J., June 23-28, 1924.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, University of Pittsburgh; Annual Meeting, Boulder, Colo., June 25-28.

The Society of Engineers of Eastern New York at its annual meeting April 10 elected Professor LeRoy W. Clark, of Rensselaer Polytechnic Institute, president; Arthur Bibb, secretary; Henry Souder and Edgar Croasdale, both of the General Electric Co. at Schenectady, as vice-president and treasurer, respectively. The speaker of the meeting was E. F. W. Alexanderson, chief engineer of the Radio Corporation of America.

The Engineering and Technical Societies of Rochester will hold their annual dinner on April 26, at Powers Hotel. The speaker will be Dr. Harry Webb Farrington.

The New York Section of the American Water Works Association will hold its last meeting of the year at Binghamton, N. Y., on April 28, with a paper on "Filtration" by B. Nelson, Chemist, Binghamton Water Department.

Personal Notes

EDGAR G. RITCHIE, engineer of water supply, Metropolitan Board of Works, Melbourne, Australia, is in this country, investigating American practice in high earth-dam construction, pipe-line experience and other methods, materials and maintenance practice.

C. A. PAQUETTE has resinged his position as chief engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry. to become the president of the White Construction Co., contractors, Chicago. Mr. Paquette was born in Detroit, Mich., April 2, 1872, and was graduated from Notre Dame University in 1891, entering the service of the Lake Shore & Michigan Southern Ry. as a transitman the same year. The following year he went to the Peoria & Eastern Ry., becoming engineer, maintenance-of-way in 1894, and a division superintendent in 1899, going to the Cleveland, Cincinnati, Chicago & St. Louis Ry. as a division superintendent in 1906, later becoming assistant chief engineer and then chief engineer of the same road.

RAYMOND D. STARBUCK, heretofore assistant vice-president, New York Central Railroad Co., has been appointed vice-president in charge of operations to succeed P. E. Crowley, elected president of the New York Central Lines. Mr. Starbuck was born at Fort Ann, N. Y., July 26, 1878, was graduated from Cornell University and entered the service of the Michigan Central R.R. as an assistant engineer in 1903. In 1912 he became special engineer to the vice-president of the New York Central & Hudson River R.R. at Chicago and in 1915 was transferred to New York as special engineer on the staff of the vice-president in charge of operations. In May, 1916, he became assistant to the vice-president and in February of the following year was appointed assistant general manager, lines west of Buffalo, and later assistant regional director of the eastern region for the U. S. Railroad Administration. At the termination of federal control he was appointed assistant vice-president, New York Central Railroad Co., and later to the position which he occupied up until the time of his recent promotion.

RALPH FENNO PROCTOR, chief engineer of the Maryland Casualty Co., Baltimore, has been appointed a member of the City Service Commission, Baltimore. Mr. Proctor is a graduate in engineering of Cornell University and formerly was with the United States Lake Survey and later practiced engineering in New York. He became associated with the Maryland Casualty Co. about 12 years ago. During the war he had charge of construction work at Camp Meade, Maryland, ranking as a major. Later he was placed in charge of the Curtis Bay Ordnance Depot and was made a lieutenant-colonel.

GEORGE A. HARWOOD, heretofore assistant to the president, New York Central Lines, has been appointed vice-president in charge of improvements and developments. He studied both civil and electrical engineering at Tufts College, being graduated in 1898, and for two years thereafter was in the employ of the Boston & Maine R.R. In 1900 he went to the New York Central as a draftsman and worked up through the engineering department until in 1906 he became chief engineer of the electric zone improvement at New York City. In 1916 he was appointed engineering assistant to the vice-president, occupying the same position under federal control in 1918, and in July, 1918, was appointed corporate chief engineer, New York Central Lines. In February, 1920, he was appointed assistant to the president, which position he has occupied up until the time of his promotion to the vice-presidency.

BANCROFT HILL, harbor engineer and president of the Harbor Board of the city of Baltimore will retire on June 1 to engage in private practice with offices at 712 Keyser Building, but will continue his engineering connection with the Port Development Commission. Mr. Hill is a graduate of the Massachusetts Institute of Technology and served successively with the engineering department of the Du Pont Co., the Piedmont and Northern R.R. and the Baltimore and Ohio R.R. In Baltimore he took charge of the Artesian and Suburban Water Companies and engaged in other engineering work. In 1919 he was appointed harbor engineer and president of the Harbor Board. He afterward became engineer for the Port Development Commission and designed the proposed McComas and Patapsco terminals.

Obituary

HARLEY D. ORMES, construction engineer of Milwaukee, Wis., died at Pasadena, Calif., April 13, from an attack of apoplexy; his age was 50 years. He was in the west to supervise the installation of a new municipal lighting plant unit in Pasadena.

GEORGE W. MCNULTY, New York City, civil engineer and at one time assistant to Colonel Roebling in construction of the Brooklyn Bridge, died April 12 at the age of 72 years. During Colonel Roebling's illness, Mr. McNulty carried out his plans and assisted in the completion of the bridge. Then he became a contractor and installed the cable system on Broadway and built the subway from Times Square to Columbus Circle in New York City. Later he built Sunnyside Yard for the Pennsylvania Railroad Co.

W. F. CAMPBELL, a member of the engineering staff of the Canadian National Rys., died recently in Montreal in his thirty-ninth year. Mr. Campbell was born in Greenville, P. Q. He entered the employ of the Canadian government in 1905 during the preliminary survey of the National Transcontinental Ry.

DANIEL TERRY, general superintendent for the Walsh Construction Co. on the Castleton cutoff near Albany, N. Y., was accidently drowned in the Hudson River near the new bridge on March 18. Mr. Terry fell into Mill Creek and was swept into the river before aid could reach him. Mr. Terry was a civil engineer gradute of the University of Pennsylvania.

LINDON WALLACE BATES, retired civil engineer and contractor, formerly chairman of the engineering committee of the Submarine Defense Association and vice-chairman of the Commission for Relief in Belgium, died in Paris, France, on April 22 following a stroke of paralysis. Mr. Bates had been ill for three years. He was 66 years old at the time of his death. An extended biography will appear in a later issue.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

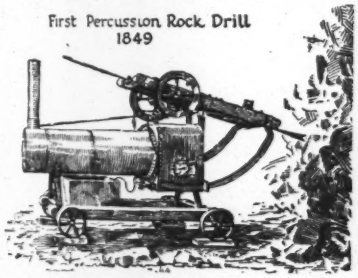
Construction Equipment—Past and Present

A Series of Historical Sketches of the Origin and Development of Machines for Contractors and Engineers

I—The Rock Drill

"MY FIRST idea of ever driving a rock drill by direct action came about in this way: I was sitting in my office one day, after my business had failed, and happening to take up an old steam cylinder, I unconsciously put it in my mouth and blew the rod in and out, using it to drive in some tacks with which a few circulars were fastened to the wall. That was my first idea on the subject."

These words were spoken just fifty years ago when J. W. Fowle was testifying before a committee of the Massachusetts Legislature regarding the drill patent claims of Charles Burleigh, whose machines had been used in driving the Hoosac tunnel. While Fowle takes rank among the pioneers in the development of the rock drill, it was J. J. Couch, of Philadelphia, who designed and patented in 1849 the first percussion rock drill. This was a ponderous steam-operated crank and flywheel machine in which the drill steel passed through the piston of the steam cylinder and was alternately caught, drawn back and thrown like a lance against a face of rock, as shown in the accompanying sketch. Clumsy and inefficient, this machine of Couch's was the precursor of the rock-drill of today.



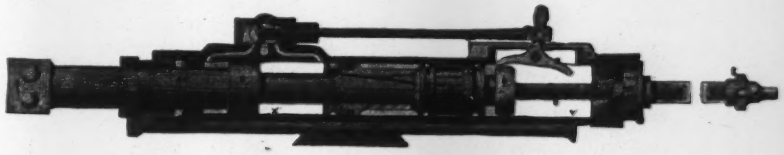
The First Rock Drill Developed by J. J. Couch

The first important stage in the development of this tool was made when Fowle, who had been associated with Couch in producing the first machine, opened up possibilities for the practical use of the drill by attaching the steel bit directly to the piston or crosshead. Fowle fi'ed a patent claim for his device, using steam, in 1849, and a year or two later used compressed air. His big contribution to the art was the direct drive of the drill steel by the piston, but he was a mechanical genius without funds, and his device made little commercial headway until his patent rights were purchased by Burleigh.

In the Fiftieth Anniversary Issue of Engineering News-Record, April 17, p. 667, there appeared a summary of the development of construction machinery and an interpretation of its influence during the last half century. That brief review, it was explained, constituted an introduction to a series of special articles dealing at greater length with the origin and improvement of the more important types of contractor's equipment. The first article of the series on "The Rock Drill" appears herewith; others will follow in succeeding issues.

This was in the early sixties when engineering interest was focused on two great railway projects, the Hoosac tunnel in Massachusetts and the Mount Cenis tunnel under the Alps in Europe. "It is to the Hoosac tunnel," says Henry S. Drinker in his book "Tunneling," "that we owe the development of rock drilling in America." Using the general principles developed by Fowle, Burleigh so improved the machine that it was installed in 1866 on the Hoosac tunnel work.

Hoosac Tunnel Work — Actual work on the Hoosac tunnel commenced in 1858. Hand drilling was employed until Oct. 31, 1866, when Burleigh rock drills were first introduced. These drills, combined with the substitution of nitroglycerin for black powder as an explosive, greatly increased the rate of driving. Many disheartening delays and interruptions occurred, however, due chiefly to failure of the earlier type of drilling machine. While the Burleigh drill was a great stride forward in the development of the rock drill, it was so heavy and so complicated that it was said that "only a corporation backed by a state treasury could afford to use it." Figures from Brunton and Davis' book on "Modern Tunnelling" show the cost of the tunnel to be $10,000,000, or $398 per lineal foot.



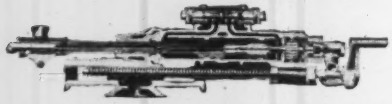
Section of Burleigh Drill, Showing Valve Mechanism

During this period developments also were occurring in Europe. A drill had been developed by Sommeiller for use in the Mount Cenis tunnel; it was approved by the official commission in charge of that work in 1857 and in 1861 the triumph of this machine as a practical tunneling tool had been demonstrated.

Following Burleigh, other inventors, including Simon Ingersoll, Sergeant, Wood, Waring, Githens, Rand and others, made numerous improvements in the rock drill and laid the foundation for bringing the machine up to its present state of mechanical perfection. As these improvements were made the manufacture of the so-called reciprocating piston rock drill began to assume a commercial importance. Companies now prominent in this field had their beginnings in the early seventies. The Rand Drill Co. was organized in 1871, the Ingersoll Rock Drill Co. came into being about the same time, while the records of the Sullivan Machinery Co. date back to 1869. The first Sullivan machines were of the diamond-pointed stone channeling type and were used in Vermont quarries. The direct-acting steam or compressed air driven stone channeler followed and was extensively used on the Chicago Drainage Canal in 1892 and on the Niagara Falls wheel pits in 1898.

Ingersoll Drill Mounted on Tripod (1873)

The Rand organization, headed by two brothers, C. Addison and J. R., centered their attention on the mining field, while Ingersoll supplied drills



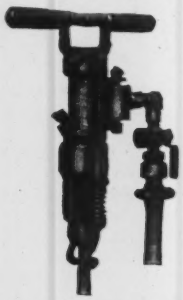
Spool Valve Water Type Rock Drill

mainly for open-cut and rock tunneling work.

Among the early mechanical developments that occurred were the replacement of the tappet valve of the Burleigh drill by an independent steam-thrown valve, the invention of Henry C. Sergeant in 1873, and brought to its final state of development in 1878. In 1884 Sergeant introduced his auxiliary valve drill, bringing with it the release rotation and a spool valve motion controlled by a crescent-shaped piece in contact with the main piston.

A great many of the improvements made were the result of experience in the Lake Superior mining region. Sergeant, the owner of a small machine shop in New York, made the repairs on Simon Ingersoll's first drill which broke during its initial test. Sergeant induced Jose F. deNavarro, a New York manufacturer and real estate owner, to purchase Ingersoll's patents and organize the Ingersoll Rock Drill Co. Later the Sergeant Drill Co. was formed in 1885 and merged into the Ingersoll-Sergeant Drill Co. in 1889. The merger of the Ingersoll and the Rand organizations occurred in 1905.

Until the nineties, rock drills had been heavy, unwieldy tools. The metal mines developed a need for a lighter machine and among others Albert Ball



Hand Hammer Drill (Sullivan)

and Thomas Officer of the Sullivan company assisted in producing the "baby" or stoping drills which could be mounted on a light bar by one operator.

Hammer Drill Introduced

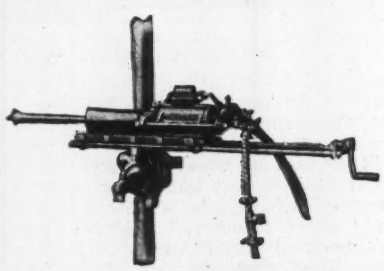
The Hammer Drill—In 1896 a new milestone in rock drill practice was established when J. George Leyner, of Colorado, introduced the hammer drill. Up to this time the drill steel had always moved with the piston, this being the essence of Fowle's invention. Leyner, however, conceived the then radical idea of eliminating the reciprocating movement of the drill steel, detaching it from the piston and striking its end with a hammer in the form of a floating cylinder piston.

The adoption of this principle, together with the use of hollow drill steel to which water and air were fed to cool the bit and wash out the rock cuttings, marked a new drilling epoch, making possible the use of a lighter machine and the striking of a greatly increased number of blows. The No. 7 Leyner drill is regarded as the father of the present-day rock drill; it included in its design the Sergeant release rotation, the rifle bar rotation sleeve chuck, the water and air feeds, the first automatic lubricator, enclosed-in-the-machine throttle construction and split front head with a front head cap retained by through bolts. Leyner spent almost fifteen years perfecting his hammer drill and in 1910 saw its adoption in the Lake Superior copper mines. It emerged successfully from this test and so far as type is concerned became the world's standard. With the new machine, later acquired by the Ingersoll-Rand Co., it was possible, on account of the lighter weight, to dispense with the cumbersome mountings in the form of carriages and tripods on which drills had previously been operated, and use bars and columns.

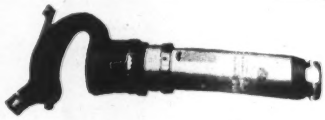
Modern Leyner-Ingersoll Drill

In 1906 a hammer type of drill with front end rotation was developed by George H. Gilman of the Sullivan organization, and a few years later automatic rotation of the drill steel came into general use. Since then improvements in drill design and manufacture have been largely confined to reducing weight and improving materials so as to secure greater strength, resistance to wear, increased drilling speed and efficiency through improvements in valve motion and rotation. The piston or reciprocating drill still survives, but its use is confined largely to open cut work on tripods or quarry bars. Even on these operations the light hammer drill is a keen competitor. An outgrowth of Leyner's invention was the development of the one-man hammer drill, widely used for shaft sinking and other operations.

As part of the history of the hammer drill should be recorded the machine built by Schmucker, who had used a Boyer chipping hammer with a drill steel to demolish the concrete foundation in one of the yards of the Chicago & Northwestern Ry. In this demonstration the drill steel was rotated by a hand wrench. Schmucker, then in charge of the railway shop, left that position, went to Denver and built a hammer type of drill.



Sullivan Rock Drill on Column Mounting



Boyer Riveting Hammer

Pneumatic Hand Tools

More recent developments in the air drill line include the paving breaker for removing street pavements, walls and floors, and a compressed air spader for excavating clay and hard pan. The modern hand hammer drill weighs only about 40 lb. and uses hollow steel with either air or a combination of air-water jet to clean the hole. It will drill holes up to 30 ft. in depth under favorable conditions. Mounted types for tunneling work weigh from 130 to 200 lb. and universally employ the water jet, although for open work the water feed is sometimes dispensed with. The development of hollow drill steel greatly hastened the acceptance as a standard of the water jet machine, which is made of the finest and toughest alloy steels obtainable.

While the attention of drill designers has been fixed for many years on the problem of turning out an efficient machine, it is only recently that emphasis has been placed on the drill steel, on which the entire drilling operation is pyramided. The first air-operated sharpener of modern design was perfected in 1906 by Leyner. Within the past few years, however, compressed-air drill sharpening machines and carefully regulated oil forges and tempering furnaces have been perfected, so that now any blacksmith can furnish drills with accurately forged bits which follow in the hole and which are carefully tempered to provide the greatest resistance to breakage and wear. At the same time these machines forge the drill shanks to withstand the blows of the hammer piston without breakage or without damaging the machine itself.

The Riveting Hammer

Closely associated in mechanical principles with the rock drill is the modern pneumatic riveting hammer. Joseph Boyer, of St. Louis, devised a compressed air chipping hammer which passed through several stages of development until, as a result of experience with it during the construction of the Cincinnati-Covington bridge in 1898, it was perfected by the Chicago Pneumatic Tool Co. as a machine which has revolutionized practice in driving rivets pneumatically. From the riveting hammer it was but a short step to the portable air drill which soon won wide favor, and later to the portable electric drill.

With regard to the development of the pneumatic riveting hammer, the records show that in 1897 Boyer produced a jam riveter for use where rivets could be backed up by an extended tailpiece; it was not thought possible

to make a pneumatic riveting hammer which could be held in the hand while driving the rivet. When these jam riveters were being used on the reconstruction of the Cincinnati-Covington bridge in 1898 it was found that some rivets had to be driven where the riveter could not be backed up. A breast-plate was attached to the rear end of the Boyer tool in place of the extension or tailpiece and a rope support was cast around the neck of one of the workmen and attached to the front end of the tool. With this arrangement the rivets were driven successfully. While this work was under way W. O. Duntley, of the Chicago Pneumatic Tool Co., visited the job and conceived the possibility of the hand riveting hammer. He placed the information before Mr. Boyer, who later produced a riveting hammer of the two-valve type which bears his name. A year later this machine was improved and made into a single-valve unit. The riveting hammer has made possible the erection of all classes of steel structures in only a fraction of the time formerly required, for today an ordinary operator will drive from 1,000 to 1,500 rivets in 10 hr. as against from 250 to 300 rivets in the same period using hand methods. Under favorable circumstances with the pneumatic hammer, an operator can drive 2,500 to 3,000 rivets in 10 hr.

Rotary Air Drill

Another step in the development of the portable rotary air drill occurred in 1898 when Boyer, employing a principle conceived by Manning in 1895, devised a machine with three cylinders, triangularly arranged, which revolved around a fixed crankshaft within an inclosed housing. This machine was widely marketed by the Chicago Pneumatic company. Then came the Keller rotary drill, followed by the six-cylinder unit made by Kimman Bros., which was evolved into the Little Giant portable air drill of today. In 1905 the Chicago Pneumatic Tool Co. introduced the heavy duty electric drill.

In the space here available it is not possible to cover in detail the various mechanical improvements made since the first large-scale, successful use of the rock drill in the United States on the Hoosac tunnel. Among the more important have been a device for automatically rotating the drill steel; the independent valve motion control; the introduction of side-rod construction; automatic lubrication; and split front head with through bolts.

Manufacturers of the modern rock drill claim it to be a machine that combines more power in less space and weight than any engine ever invented. Reviewing the events of the last half century, this tool has been the key which has opened up the rock barriers across the routes of our transcontinental railways, unlocked the great treasure chest of the earth's coal and metal resources, uncovered foundations for skyscrapers, dams and bridges, and performed a host of other services in providing civilization with its present day utilities.

(Next week: The Power Shovel.)

Companies Apply for Space at Water-Works Exhibit

J. E. O'Leary, chairman of the Exhibit Committee of the Water Works Manufacturers Association, reports that up to April 18 the companies named below had applied for space at the exhibit during the annual convention of the American Water Works Association to be held at the Hotel Astor, New York, May 19-24:

American City.
Mueller Mfg. Co.
Leadite Co.
Neptune Meter Co.
Water Works Equip. Co.
A. P. Smith Mfg. Co.
Fire & Water Eng.
U. S. Cast Iron Pipe & Foundry Co.
Gamon Meter Co.
R. D. Wood & Co.
Union Water Meter Co.
Thomson Meter Co.
Eddy Valve Co.
Lead Lined Iron Pipe Co.
Buffalo Meter Co.
Hersey Mfg. Co.
Pitometer Co.
McWane Cast Iron Pipe Co.
Electro Bleaching Gas Co.
Wallace & Tiernan Co.
Canadian Engineer.
Hays Mfg. Co.
Chicago Bridge & Iron Works.
Sullivan Machinery Co.
Central Foundry Co.
Engineering & Contracting.
Engineering News-Record.
Public Works.
W. & L. E. Gurley.
National Tube Co.
Van Gilder Water Meter Co.
Simplex Valve & Meter Co.
Edward E. Johnson.
Bingham & Taylor.
National Water Main Cleaning Co.
Pittsburgh Testing Laboratory.
Builders Iron Foundry.
Badger Meter Mfg. Co.
East Jersey Pipe Co.
Kelly Well Co.
National Meter Co.
American Cast Iron Pipe Co.
Mathieson Alkali Works.
Layne & Bowler Co.
Worthington Pump & Machinery Corp.
Rensselaer Valve Co.
Kennedy Valve Co.
Pittsburgh Meter Co.
Lock Joint Pipe Co.
Columbian Iron Works.
Elliott-Fisher Co.
Birch Mfg. Co.
Federal Meter Co.
Lap Joint Impervious Pipe Co.
Chapman Valve Co.
Warren Foundry & Pipe Co.
Geo. A. Caldwell Co.
Payne Dean, Ltd.
Ludlow Valve Co.
Ford Meter Box Co.
Roberts Filter Mfg. Co.
Pennsylvania Salt Mfg. Co.
Ross Valve Co.

Business Notes

Heltsel Steel Form & Iron Co., Warren, Ohio, reports two of the largest steel road form orders it has ever received, one from the C. F. Lytle Construction Co., Sioux City, Iowa, for 10,000 ft. of 9-in. road forms, to be used on a large job in Florida, and the other for 6,000 ft. of 8½-in. forms from the Union Paving Co. of Philadelphia. The Lytle order makes a total of 30,000 ft. of forms purchased by that company during the past three years, and the Union Paving order makes a total of over 43,000 ft. of forms purchased by them in three years.

Wood Shovel & Tool Co., Piqua, Ohio, announces that H. L. Gilliam, formerly district sales manager at Norfolk, Va., has been placed in charge of the New York office and will have charge of sales both to the hardware and railroad trade in the metropolitan district. In the past the hardware trade was served by J. C. McCarty & Co., while the railroad trade was in charge of H. H. French. The McCarty company is now handling the products of the Skelton Shovel Co., Dunkirk, N. Y., and Mr. French is associated with the Motor Terminals Co., New York, engaged in the interchange of freight in demountable truck bodies.

Concrete Tile Machinery Co. and its subsidiary, the Hawthorne Roofing Tile Co., Cicero, Ill., announces the appointment of Leslie H. Allen, as general manager. Mr. Allen is well known through his work with the Portland Cement Association in promoting the use of concrete in home building, in developing the science of concrete construction in small homes, and in technical research in the concrete products field.

Equipment and Materials

Cut Wide Drainage Ditch with 30-In. Trench Excavator

Application of a 30-in. Parsons trench excavator to the cutting of a drainage ditch 8 ft. 4 in. wide and 5 ft. deep has been made by the Public Works Department of Rocky Mount, N. C., under the direction of L. M. Jordan, superintendent of the gas department. The ditch was 200 ft. long and Mr. Jordan's

figures show that the work was done in 10 hr. at a cost of $37.50 for labor, gasoline and repairs.

As a preliminary the boom on the machine was extended from 8 to 12 ft. The method followed was to make a cut beginning on one side of the ditch, then move the machine over 30 in. and repeat the operation until the full width had been taken out.

In explaining the cost figures below, Mr. Jordan says: "We dug the ditch in 10 hr. actual working time, but in our cost charges we included the time to extend the boom from 8 to 12 ft., also the time in moving from the shed in which we store the machine to the job and back again."

ITEMIZED COST

2 days operator	$12.00
2 days each, two helpers	10.00
40 gal. gasoline	8.00
Oil	2.00
Repairs and depreciation	5.50
	$37.50

The repairs included the replacement of one babbitted bearing and two brass bearings which had become slightly worn.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Prices and Labor Rates During the Past Fifty Years

Materials Prices and Labor Rates 1874-1924 with Explanations of Figures and Also of Diagram in April 17 Issue

During the past fifty years the trend of materials prices was fairly flat, until the war years, while that of wages was consistently upward. Under war demands, both prices and wages skyrocketted, prices going the higher. To use to the best advantage the tabulations and charts which *Engineering News-Record* has prepared requires an understanding of certain facts and events.

In the chart showing materials prices, *E. N.-R.*, issue of April 17, the dotted portion of the steel curve represents the wrought-iron I beams at the Pittsburgh mill, which in 1885 reached $3.12 per 100 lb., a price only slightly below the cost of structural steel at Pittsburgh in 1917.

Portland cement when first placed on the market in 1879 was higher in price than it is to-day, and until 1882 remained higher than for any year except 1920. In 1879, however, cement was sold in wooden barrels as compared with the present system of calling four 94-lb. sacks a barrel of cement. Until as late as 1907 a single wooden barrel of cement cost about 30c. more than a barrel consisting of four sacks. The 1874 to 1879 quotations are for Rosendale cement.

The lumber prices from 1874 to 1909, inclusive, are for long-leaf yellow pine boards, 1 x 12-in.; from 1910 to date for long-leaf yellow pine timbers, 3 x 12-in.; all per M ft., b.m., in approximately 20-ft. lengths. In 1912 pine lumber prices had reached a point not touched again until 1918. The slump, which occurred meantime, reached the lowest point between 1914 and 1915. It was caused by the opening of the Panama Canal, when Douglas fir shippers on the West coast could send the lower priced lumber through to the Atlantic seaboard in competition with Southern pine.

The pig-iron curve from 1874 to 1897 inclusive, covers No. 1 foundry, Southern. From 1898 to date prices are for No. 2 foundry, Southern, with the following exceptions: No. 1 foundry, Southern, is used for 1905 and No. 2 foundry, Northern, for the year 1912. The price difference between the grades is only 25 to 50c.

In September, 1918, prices of building materials were fixed by the War Industries Board of the United States Government. This action controlled foreign government purchases as well

COMPARISON OF BASIC BUILDING MATERIALS PRICES—1874 TO 1924

Average yearly prices, wholesale to dealers or contractors, in carload lots, f.o.b. New York, except in the case of steel structurals, which are f.o.b. Pittsburgh

	Pig iron No. 1 F'd'y, Anthracite, per Gross Ton	Brick Common Building, per M.	Cement Rosendale, per bbl.	Lime Common, per bbl.	Lumber Yellow Pine 1-in., per M.ft. b.m.	Wrought-iron I-Beams, Channels, etc., per 100 lb.
1874	$30.25	$7.41	$1.48	$1.50	$26.00	.....
1875	25.50	7.12	1.25	1.40	21.00	.....
1876	22.25	5.87	1.20	1.00	21.00	.....
1877	18.88	4.93	1.10	.80	20.00	.....
1878	17.63	4.71	.95	.70	20.00	.....
			Portland, per bbl.			
1879	18.03	4.08	2.70	.80	20.96	$2.78
1880	28.50	7.00	2.88	.87	19.00	....
1881	25.12	7.50	2.72	.95	19.00	....
1882	25.75	7.12	2.82	1.01	19.00	....
1883	22.38	8.28	....	1.05	19.00	....
1884	19.88	6.65	2.60	.95	19.00	....
1885	18.00	6.10	2.28	1.00	18.66	3.12
1886	18.71	7.51	2.28	1.00	19.00	3.00
1887	20.92	7.43	2.07	.82	19.00	....
1888	18.88	6.50	2.16	.83	16.75	....
1889	17.75	7.06	2.23	.92	20.31	....
1890	18.40	6.65	2.25	.95	21.75	....
1891	17.52	5.53	2.38	.87	18.00	....
1892	15.75	5.77	....	.93	18.50	....
1893	14.52	5.83	....	.93	8.50	....
						Structural Steel Shapes, Beams, Channels, etc., per 100 lb., f.o.b. Pittsburgh
1894	12.75	5.00	....	.85	18.50	1.20
1895	11.50	5.31	1.97	.78	16.92	1.35
1896	12.50	5.06	2.00	.69	16.42	1.60
1897	12.10	4.94	1.97	.72	16.44	....
	No. 2 F dry Southern					
1898	10.75	5.75	2.00	.70	15.75	1.27½
1899	15.50	5.69	2.05	.75	16.25	1.45
1900	22.00	5.25	2.16	.68	24.50	1.95
1901	14.37½	5.77	1.89	.77	17.50	1.60
1902	17.25	5.39	1.95	.81	21.00	1.60
1903	22.37½	5.91	2.03	.79	23.50	1.70
1904	13.75	7.50	1.67½	.80	21.50	1.60
1905	17.89 (No. 1)	8.10	1.43	.89	24.92	....
1906	17.75	8.55	1.55	.95	29.33	1.60
1907	26.25	6.16	1.55	.95	30.50	1.75
1908	16.50	5.10	1.46	1.05	30.50	1.76
1909	15.50	6.39	1.41	1.05	33.04	1.50
					Long-leaf Yellow Pine 3-in.	
1910	17.10	6.12½	1.43	.92	36.00	1.52½
1911	15.37½	5.31	1.43	.92	36.00	1.42½
1912	14.75 (Northern)	6.75	1.34	.92	40.00	1.20
1913	16.43¾	6.75	1.58	.97	35.25	1.46
1914	14.56	5.60	1.58	.97	29.50	1.11
1915	15.29	5.50	1.04	1.06	27.75	1.33
1916	22.20	8.69	1.62	....	32.62	2.48
1917	33.75	9.40	2.16	....	37.33	3.39
1918	39.90	10.98	2.53	2.21	42.66	3.00
1919	39.01	17.90	2.63	2.65	50.87	2.61
1920	47.73	18.00	3.00	3.18	63.75	2.79
1921	38.28	17.40	2.73	3.49	48.16	2.05
1922	30.77	16.91	2.45	3.00	47.05	1.69
1923	32.12	20.00	2.66	3.12	55.22	2.50
Apr. 24, 1924	28.00	20.00	2.55	3.12	58.00	2.40

BUILDING TRADES WAGE RATES—1874 TO 1924

New York, per hour

	Carpenter's 10 hr. Day	Bricklayers' 8 hr. Day	Hodcarriers	Common Laborer's 10 hr. Day	Structural Iron-Workers
1874	$0.23	$0.43	....	$0.14	....
1875	.22½	.37	....	.14	....
1876	.21	.31	....	.14	....
1877	.20	.31	....	.12	....
1878	.18	.31	....	.11	....
1879	.17	.31	....	.11	....
1880	.18	.34	....	.12	....
1881	.19	.46	....	.13	....
1882	.21	.50	....	.15	....
1883	.21	.50	....	.13	....
1884	.21	.50	....	.13	....
1885	.20	.50	....	.13	....
1886	.21	.50	....	.13	....
1887	.21	.50	....	.14	....
1888	.22	.50	....	.12	....
1889	.22	.50	....	.13	....
	8 hr. day		8 hr. day	9 hr. day	
1890	.43	.47	$0.28	.14	....
1891	.43	.47	.28	.14	....
1892	.44	.50	.29	.14	....
1893	.43	.50	.30	.14	....
1894	.44	.50	.30	.14	....
1895	.43	.50	.30	.14	....
1896	.44	.50	.30	.14	....
1897	.44	.50	.29	.14	....
1898	.44	.50	.30	.14	....
1899	.45	.55	.33	.14	....
1900	.50	.56	.33	.14	....
1901	.50	.59	.33	.19	....
1902	.51	.65	.36	.17	....
1903	.56	.65	.36	.16	....
1904	....	....	....	....	....
1905	....	....	....	....	8 hr. day
1906	....	....	....	....	$0.60
1907	.62½	.70	.37½	.22	.60
1908	.62½	.70	.37½	.22	.60
1909	.62½	.70	.37½	.22	.60
1910	.62½	.70	.37½	.22	.62½
1911	.62½	.70	.37½	.22	.62½
1912	.62½	.70	.37½	.23	.62½
1913	.62½	.70	....	.22½	.62½
1914	.62½	.75	....	.22½	.62½
1915	.62½	.75	....	.25	.62½
1916	.62½	.75	....	.25	.66
1917	.69	.75	....	.30	.69
1918	.69	.81	....	.40½	.80
1919	.81½	.87½	.57½	.55	.87½
1920	1.08	1.17	.77½	.75	1.11
1921	1.12½	1.25	.87½	.77	1.12½
1922	1.12½	1.25	.87½	.58	1.12½
1923	1.20	1.42	.95	.61	1.16
1924	1.31¼	1.50	1.00	.68¾	1.25

as domestic buying. The ban was lifted in March, 1919.

The lime prices here given are for a "large barrel" (280 lb.).

Interpretation of Labor Rates

The chart in *E. N.-R.*, issue of April 17, also shows that wages in the building trades began to ascend definitely between 1899 and 1907. From that period until the war years the curves are generally flat. The soaring began in 1917. At present, wage rates of the skilled trades in New York are the highest in the half century. Common labor dropped 14½c. in value (to 59½c.) in 1922, and now stands at 60½c.

Bricklayers began the 8-hr. day in 1872, as against 10-hr. formerly, and changed from the 48-hr. week to the 44-hr. in 1899. Then, as now, the bricklayers were first to gain labor advantages. That wages in this craft were usually in advance of most of the other trades during the last fifty years is shown in the chart. Hodcarriers began the 44-hr. week in 1900.

Carpenters were working ten hours per day in 1874, changing to 8-hr. in 1890. The 44-hr. week began in 1900.

Common laborers (excavating) changed from the 10-hr. to the 9-hr. day in 1890. Since 1919 the 8-hr. day has been in force.

Wages remained at the high rates reached in the latter part of 1920 and the first part of 1921, throughout 1922. Skilled building trades' wage schedules remained unchanged during the 1921 depression despite widespread unemployment.

Sources of the Data

In compiling prices of construction materials since 1874, it was found that the first forty years were the hardest. *Engineering News* published quotations first in 1879, and not again until 1885 and 1886, when the *Engineering News and American Contract Journal* published monthly prices of all basic materials except pig-iron.

The charts in the issue of April 17 and tabulations in this article have been compiled, where possible, from

(Continued on p. 750.)

Public Bond Sales in March Largest for 1924

Public bond sales for March are in excess of the two preceeding months. The long time issues for this month totaled $96,035,661 according to *The Commercial and Financial Chronicle*. This total may be compared with $92,486,572 for January, $92,988,074 for February 1924 and $69,235,244 for March, 1923. The chief fact to be gained from these sales is the predominance of large issues and the decline in the number of separate issues.

San Francisco, Calif., placed the largest issue of the month—$10.281,000. The highway, road and bridge bonds of the State of Alabama for $7,000,000 was second. West Virginia placed $5,000,000 and the same amount was issued by St. Louis, Mo.

Milwaukee County of Wisconsin sold a block of 4¾'s, "Metropolitan Sewerage Bonds," totaling 3,736,000.

In the accompanying table, six of the issues were sold at par, fifty-one above, and only two below.

REPRESENTATIVE PUBLIC BOND SALES, MARCH, 1924

State	Purpose	Amount	Rate per Cent	Sold For	Basis	Dated	Maturity	Purchased By
Alabama	Highway and bridge	$7,000,000	4½	101.45	4.41	June 1	1949—62	A syndicate
West Virginia	Road	5,000,000	4½	100	4½	Apr. 1	1929—48	State depositories
Louisiana	Gen. improvement	3,000,000	4¾	100	4¾	Dec. 1	1933—73	W. R. Compton Co. and others, New York City
County								
Adams, O.	Road improvement	57,500	5½	101.05	5.27	Feb. 1	1924—33	First Nat. Bk. of West Union
Black Hawk, Ia.	Road	950,000	5	100.15	4.96	Mar. 1	1924—39	White Phillips Co., Davenport, Ia.
Burlington, N. J.	Road	275,000	5	101.85	4.615	May 1	1925—34	Graham, Parsons & Co., New York City
Cannon, Tenn.	Highway	75,000	6	105	5.714	Apr. 1	1924—44	Caldwell & Co. of Nashville
Chautauqua, N. Y.	Highway	250,000	5	102.38	4.50	Apr. 1	1929—30	Bonbright & Co., New York City
Clay, Minn.	Road	250,000	4¾	100.36	4.71	Mar. 1	1935—44	Geo. S. Ring of St. Paul, Minn.
Cass, Ind.	Road	36,700	5	100.81	4.84	Jan. 15	1925—34	J. F. Wild & Co., Indianapolis
Chester, Pa.	Road and bridge	500,000	4½	100.82	4.19	Mar. 1	1934—54	Townsend Whelan & Co. and others, Phila.
Erie, O.	Road	99,900	5½	101.83	5.14	Mar. 1	1924—34	W. L. Slayton & Co., Toledo
Emmett, Mich.	Road	50,000	5	103.574	4.71	Nov. 1	1942	Emery, Peck & Rockwood
Elkhart, Ind.	Road	64,000	5	102.30	4.70	Jan. 15	1924—43	J. F. Wild & Co., Indianapolis
Franklin, O.	Sewer	135,000	5½	102.54	4.97	Sept. 1	1925—34	Seasongood & Mayer, Cincinnati
Huron, O.	Ditch	15,700	5½	100.89	5.24	Oct. 1	1925—29	The Herrick Co., Cleveland
Henry, O.	Road improvement	198,800	5½	102.29	4.76	Sept. 1	1925—33	Provident Savings Bank & Trust Co., Cincinnati
Jay, Ind.	Drainage	20,408	6	100.63	5.66	Dec. 8	1924—26	City Trust Co., Indianapolis
Mower, Minn.	Road	35,000	4½	102.42	4.53	Mar. 1	1935—44	Northwestern Trust Co., St. Paul
Ocean, N. J.	Bridge	42,000	5	103.05	4.725	Jan. 1	1925—54	B. J. Van Ingen & Co., New York
Randolph, Ind.	Road	136,100	5	101.20	4.81	Mar. 24	1924—34	The Farmers & Merchants Bank, Winchester
Schuyler, N. Y.	Highway	100,000	4½	100.026	4.37	.....	1944—53	Sage, Wolcott & Steele, Rochester
Sutton, Tex.	Road	100,000	5½	97.50	5.71	Feb. 1	1954	J. E. Jarratt & Co., San Antonio
Sussex, N. J.	Road improvement	197,000	4½	100.72	4.43	Jan. 1	1926—50	M. M. Freeman & Co., Philadelphia
Vermillion, Ind.	Road	30,300	5	101.07	4.79	Mar. 15	1925—34	Citizens State Bank, Newport
Vigo, Ind.	Road	62,400	5	101.05	4.76	Mar. 1	1924—33	Meyer Kiser Bank, Indianapolis
Walworth, Wis.	Highway	728,000	5	102.78	4.74	Apr. 1	1928—43	A syndicate
Wayne, O.	Road	135,000	5½	102.55	5.015	Feb. 1	1925—33	W. L. Slayton & Co., Toledo
Township								
Cataloochee, N. C.	Road	30,000	6	.....	.....	Mar. 1	1927—56	Spitzer, Rorick & Co., Toledo
Lyndhurst, N. J.	Water	75,000	4½	100	.....	Jan. 1	1926—61	R. M. Grant & Co., New York
Newbury, O.	Road improvement	4,266	5½	100.11	5.42	Jan. 1	1925—33	The Chagrin Falls Banking Co., Chagrin Falls
Port Austin, Mich.	Road improvement	10,000	5½	.....	.....	Jan. 15	1926—35	The First Nat. Bank, Detroit
Sandusky, O.	Road	16,000	5½	100.10	5.475	Feb. 1	1925—31	Bank of Mansfield, Mansfield
Municipalities								
Akron, O.	Improvement	1,793,130	5½	101.173	5.07	Mar. 1	1925—48	A syndicate, New York
Atlanta, Ga.	Street improvement	90,500	5	101.44	4.70	Mar. 1	1926—33	Hibernia Securities Co., Atlanta
Atlantic City, N. J.	Drainage	650,000	4½	101.40	4.64	Mar. 1	1925—44	A. M. Lamport & Co., New York
Annapolis, Md.	Improvement	100,000	4½	100.9184	4.42	Mar. 1	1927—46	Union Trust Co., Baltimore
Bridgeport, Conn.	School building	450,000	4½	102.818	4.25	Jan. 15	1925—54	R. M. Grant & Co., New York
Burlington, N. C.	Improvement	250,000	5½	101.41	5.61	Feb. 1	1926—59	Braun, Bosworth & Co., Toledo
Buffalo, N. Y.	Improvement	2,195,000	4½	100	.....	Apr. 1	1925—44	Buffalo Trust Co., Buffalo
Caldwell, Kan.	Paving	45,966	5	100	.....	Feb. 20	Serially	A. L. Cook, Ottawa
Canton, O.	Sewage	800,000	5	101.64	4.83	Sept. 1	1925—48	Halsey, Stuart & Co., New York
Chattanooga, Tenn.	Improvement	655,000	5	102.47	4.84	Mar. 1	1928—54	Caldwell & Co., Nashville
Denver, Colo.	Bldg.	500,000	4½	100.8175	4.42	Aug. 1	1934—38	International Trust Co., Denver
Durham, N. C.	Improvement	600,000	5	100.199	4.98	Jan. 1	1925—67	Kean, Taylor & Co., N. Y. C., and others
Dubuque, Ia.	Water	125,000	4½	100.31	4.48	Apr. 1	1937—44	Geo. M. Bechtel & Co., Davenport
Duluth, Minn.	Improvement	325,000	4½ 4½	101.65 100.13	4.55 4.48	Apr. 1	1925—49	A syndicate
Fort Meyers, Fla.	Improvement	445,000	5½	101.32	5.39	Mar. 15	1944	Atlantic National Bank, Jacksonville Prudden & Co., Toledo
Indianapolis, Ind.	Park	560,000	5	103.77	4.575	Mar. 21	1926—45	A syndicate
Montclair, N. J.	Water	1,154,000	4½	104.06	4.46	Mar. 1	1926—62	J. S. Ripple & Co., and First Nat. Bk., N. Y. C
Morgantown, W. Va.	Improvement	250,000	5½	102.85	5.12	Dec. 1	1925—39	Kanawha Valley Banking & Trust Co., Charleston
Miami Beach, Fla.	Improvement	600,000	5½	100.90	5.37	Apr. 1	1925—43	Palm Beach Bank & Trust Co. of West Palm Beach
Minneapolis, Minn.	Street improvement	677,000	4½	100.05	4.65	.....	1924—34	Wells-Dickey Co. and Eldredge Co.
Newark, N. J.	Water	975,000	4½	102.57	4.32	Mar. 1	1925—64	Ironbound Trust Co. and Federal Trust Co., N. Y. C.
Paterson, N. J.	Street improvement	325,000	4½	100.13	4.48	Jan. 1	1925—35	H. L. Allen & Co. and Outwater & Wells
Providence, R. I.	School and sewer	1,000,000	4½	98.856	4.315	Apr. 1	1954	Putnam & Storer, Boston
Sanford, Fla.	Utility	375,000	5½	100.503	5.42	Jan. 1	1954	Marx & Co., Birmingham Otis & Co., Cleveland
Utica, N. Y.	Improvement	711,356	4½	100.01	4.24	Nov. 1	1925—44	Citizens Trust Co., Utica
Watertown, Mass.	.....	620,000	4½	100	.....	.....	1924—44	Brown Bros. & Co.
Waterbury, Conn.	Water	400,000	4½	100.43	4.22	Jan. 31	1925—64	Putnam & Co., and Estabrook Co. of Hartford

Prices and Labor Rates During Last Fifty Years

(*Concluded from p. 749*)

quotations published in *Engineering News-Record* and its predecessors. This source furnishes figures for 1879, 1885, 1886, iron and steel prices from 1894 to 1909, all prices from 1910 to 1924. Figures for 1874 to 1879, 1880 to 1884 and 1887 to 1891, inclusive, are taken from the Aldrich report of the Senate Finance Committee of 1893. The Bureau of Labor Statistics supplies prices for 1892 and 1893. Prices of brick, cement and lime for 1894 to 1909 are also derived from this source, as are lumber quotations except for 1898 to 1904, when *News-Record* figures were available.

Building trades wage schedules for 1874 to 1889 are from the Aldrich report; for 1890 to 1912, from the Bureau of Labor Statistics; 1913 to date, *Engineering News-Record*.

Winter Construction Flattens Seasonal Curve

"The *present* increase each spring over the preceding winter has grown vastly less in the last two years," was said last week on p. 636, under the caption, "Increased Winter Work Is Flattening Seasonal Curve." The italicized word, "*present*," should be *per cent*.

The actual percentages of this increase are as follows: 100 in the spring of 1922; 55 in 1923, 11 for 1924.

Bids Wanted on Big Jobs

Among the projects on which bids are either asked or will soon be called for in Construction News, pp. 231 to 246, are the following:

Hospital, Philadelphia, Pa., dir. of Pub. Health, $2,000,000.

Bridge, Sherman Island, Calif., Delta Bridge Corp., San Francisco, $1,500,000.

Hotel, Duluth, Minn., M. Tullgren & Sons, $1,250,000.

Theatre, Club and Hotel Annex, Louisville, Ky., J. G. Brown, $1,000,000.

Call money showed but one rate—4 per cent, Monday, April 21.

Time loans dull at 4½@4¾ per cent.

Commercial paper gave same rate for all names—4½@4¾ per cent.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Apr. 3, the next, on May 1.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minne-apolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$3.59	—$3.75	$4.40	$3.30	$3.55	$4.20	$3.60	$3.60	$4.20
Structural rivets, 100 lb.	4.40	— 4.50	4.90	3.75	4.00	5.15	5.00	—4.25	5.00
Reinforcing bars, ¾ in. up, 100 lb.	3.49	— 3.25	3.38	3.20	3.45	3.85	3.65	3.50	3.90
Steel pipe, black, 2½ to 6 in. lap, discount	44%	53.2%	43%	47%	55.05%	36%	36.80@49.10%	45%	47.43
Cast-iron pipe, 6 in. and over, ton	61.60@63.60	54.00	61.00	57.20@60.20	61.50	69.00	60.00	65.00	60.00
Concreting Material:									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.20	2.42	2.84	2.61	2.90	2.72
Gravel, ¾ in., cu.yd.	2.00	2.00	2.38	2.00	1.85	1.90	2.15	1.50	1.50
Sand, cu.yd.	1.25	1.40	2.00	2.00	1.25@1.50	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.00	2.83	2.00	2.00	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	63.00	40.00	60.22	55.00	41.75@43.00	—49@53	36.00	28.00	65.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	3.00@3.25	1.65	1.85	1.50	• 1.40	2.70	2.10	2.80	9.50
Common brick, delivered, 1,000	23.65	12.00	14.10	11.00	15.00	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.091	.11	.064	.075	.075	.....	.11	+.12
Hollow partition tile 4x12x12, per block	.1179	.091	.11	.....	.....	.075	.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	.95	—.99	1.10	.94	1.06	+1.14	—1.05	1.15	1.18
Common Labor:									
Common labor, union, hour	.75	.30	.....	.....	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	....	.25	.30@.50	.82½	.50@.55	.35@.50	50	.62½	.25

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93¾c.; building laborers (pick and shovel men) 75c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.80 for Kelly Island and $1.70 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in iron bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Head tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on Douglas fir instead of pine. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 98.09). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3-in., $47.43; 6-in. $119.

Weekly Review of the Market

Further easing of steel and fir lumber prices and the continued fluctuation in linseed oil mark the only changes of note in this week's market.

The recent decline in steel buying is being reflected in a slowing down of mill operations. Structural steel bookings have been gradually tapering off since the first of the year. The condition is exactly opposite, however, in the case of commercial steel castings, demand for which has increased steadily since January. While much of the current steel buying is for railroad equipment, some large orders for fabricated steel have been reported during the last week.

The average price of steel shapes, plates and bars is $2.40 per 100 lb. at the Pittsburgh mills. As low as $2.20 on plates, $2.25 on shapes and $2.30 per 100 lb. for steel bars has been quoted where large tonnages were involved.

The fir timber situation is one of weakness in prices with production above normal, particularly in the Denver and Seattle districts. Yellow pine mill stocks are also fairly large, yet prices are not showing any evidence of softness. Linseed oil rose 2c. in Denver and declined 1c. in Atlanta and 2c. per gal. in San Francisco during the week.